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China: Energy

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SCIENCE & TECHNOLOGY

CHINA: ENERGY

CONTENTS

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MID-YEAR ENERGY PRODUCTION FIGURES RELEASED

OW300744 Beijing XINHUA in English 0963 GMT 30 Jun 87

[Excerpts] Beijing, June 30 (XINHUA)--China has pumped out 65.27 million tons of crude oil and 7 billion cubic meters of natural gas, increases of 4 percent and 3.2 percent over the figures for the same 1986 period, respectively, according to reports from the country's energy production departments released today.

Of the country's 16 major oil-gas fields, 11 have fulfilled or overfulfilled their targets set for the period.

Statistics show that oil products stored in the first 5 months of this year was about 1.4 million tons more than the figure for the same period last year.

The Ministry of Coal Industry announced that China's major coal mines cut 215 million tons of coal in the first half of this year, 3.55 million tons more than in the same period last year.

The Ministry of Water Resources and Electric Power reported that 23.62 million kWh electricity had been produced in the January-June period, accounting for 50.3 percent of the yearly plan, and coal consumption for every kWh power was 2 grams less than the same period last year. This meant that in the first 5 months of this year, a total of 585,000 tons of coal was saved.

/6662
CSO: 4010/57

NATIONAL CONFERENCE STRESSES PLANNED, ECONOMICAL ELECTRICITY USAGE

SK070132 Jinan Shandong Provincial Service in Mandarin 2200 GMT 6 Jun 87

[Text] The national meeting on the planned and economic use of electricity ended in Jinan on 6 June.

The meeting held that over the past few years, China has made greater achievements in planned and economic usage of electricity. However, some problems remain in this regard. Particularly, leaders at various levels have failed to consider the planned and economic use of electricity as a long-term task, the system of managing electricity usage is not perfect, and measures for management of electricity usage have not been effectively adopted. Simultaneously, economic and technological means essential to the planned and economical use of electricity have not been perfected, and the situation of unplanned power consumption has not been effectively controlled.

The meeting stressed: All localities should take planned and economical use of electricity as a long-term task and adopt economic and technological measures and essential administrative means to comprehensively economize on electricity. The management of industrial enterprises' electricity usage should be strengthened by carrying out such methods as allowing enterprises to retain the economically used portions of electricity, raising the prices of excessively used electricity, changing the pricing of electricity according to various conditions, launching a campaign of appropriate economic use of electricity, popularizing new technologies for economizing on electricity, transforming outdated technologies and equipment, and encouraging enterprises to use surplus heat to generate electricity. Simultaneously, we should strengthen the management of electricity usage among the rural areas and appropriately control the power consumption for municipal administration and people's lives.

In order to strengthen the economical use of electricity, the State Council has decided to establish a national office in charge of the work of economizing electricity under the Ministry of Water Resources and Electric Power.

/8309
CSO: 4013/76

NEW CONSORTIUM AIMS TO LINK ENTERPRISES, INSTITUTES

HK081216 Beijing CHINA DAILY (BUSINESS WEEKLY supplement) in English
8 Jun 87 p 1

[Article by staff reporter Dai Beihua]

[Text] As part of the drive to improve China's power generating industry, a new partnership corporation linking a range of enterprises, institutes and universities was set up recently.

The Beijing Electrical-Mechanical Manufacturing Consortium (BEMMC) is also going to draw on expert advice of scientists from a variety of specialist organizations.

Ai Baohui, the consortium's manager, said its aim was to work on power projects involving a generating capacity of 50,000 kW or less.

In order to meet the demands of the Seventh Five-Year Plan (1986-90), the State has approved the establishment of eight major partnership corporations in this field in Beijing, and in Liaoning and Heilongjiang provinces in the past 4 years.

Established on 21 April, BEMMC combines 45 enterprises, scientific institutes and universities.

In addition to having top leaders from China's electrical and mechanical bureaus, the consortium has invited a group of top experts who used to work for the State Council to check its project planning.

"With all these experts, we are not afraid of competition," Ai said, "although we have a lot to learn from the experienced partnership corporations."

Inside the consortium, the 45 enterprises and scientific research institutes are to operate in an atmosphere of cooperation. They support the consortium on a voluntary basis and it has received an average of 2,000 yuan from each of the 45 units.

Business for the consortium has already started, Ai said. The first contract has been signed to build a generator with a 12,000-kilowatt capacity in Henan Province.

The service fee is low, about half that charged by other corporations.

Three branch corporations of the consortium have been established in Beijing's Tongxian County, in Baoding, Hebei Province, and in Zhengzhou, Henan Province. Another seven branches will be set up in the next few years.

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CSO: 4010/53

JOINT COMPUTER PROJECT TO ANALYZE ENERGY USE

HK120650 Beijing CHINA DAILY in English 12 Jun 87 p 2

[Article by staff reporter Xu Yuanchao]

[Text] A joint computer project between China's State Commission of Science and Technology and the European Communities Commission will provide analysis and data for Beijing's energy planning and policy-making for the year 2000.

The project, called Energy Flow Analysis for the Beijing Region, was undertaken by Qinghua University, Beijing Municipal Institute of City Planning and Design, and InnoTec of West Germany, last December.

The analysis for 1985 shows 68.3 percent of primary energy in Beijing came from coal, 30.4 percent from petroleum, and 1.3 percent electricity.

A spokesman for the Institute of City Planning and Design told CHINA DAILY the use of large amounts of coal was the major cause of the increasing serious pollution in the capital, particularly in winter.

He said energy planning and associated policy-making are increasing in importance for China to reach its goal of economic development by the year 2000.

A major task in energy planning, he said, is to improve energy structure and to increase the percentage of clean energy in the capital.

In energy planning for the year 2000, computers will provide options for experts to discuss, he said.

Nic Mosar, Commissioner of the European Community, said earlier that its co-operation with China in energy planning is part of the community's energy policy. It has also many joint projects in the energy industry such as the utilization of natural gas, oil and coal.

He said the community has broad prospects for co-operation with China. Some 2,200 Chinese technical personnel have been trained in China's seven training centres, a co-sponsored programme.

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CSO: 4010/54

DEVELOPMENT OF FLUIDIZED-BED BOILER TECHNOLOGY IN CHINA REVIEWED

Shanghai DONGLI GONGCHENG [POWER ENGINEERING] in Chinese No 1, 15 Feb 87 pp 27-32

[Article by Shanghai Generating Equipment Institute: "Development of Chinese Power Plant Fluidized-Bed Boilers"]

[Text] Abstract: This paper reviews the development situation of China's power station fluidized combustion boilers, with emphasis on introducing results obtained in some key technological problems and proposing topics for further research.

I. Development Overview

China's research on developing fluidized combustion boilers has a 20-year history, with the primary goad being to burn various kinds of low-quality fuels, such as bone coal, brown coal, oil shale, low-quality bituminous coal and low-quality anthracite coal. It opens a new path for fully utilizing energy resources when there is no way to burn "waste materials" in conventional boilers. The development process can basically be divided into three stages:

A. Modifying old furnaces and mastery of fluidized combustion technology

In The 10 years from the mid-sixties until the mid-seventies, it was primarily transformation of old furnaces to use local resources, economize on superior quality coal and promote development of local industry. Typical fluidized combustion boilers used for generating electricity in this period are the 50t/h furnace of the Ganzhe Chemical Industry Plant in Jiangmen, Guangdong, and the 19t/h and 24t/h furnaces of the Yongrong Mining Bureau's power plant in Sichuan.

The 50t/h fluidized combustion boiler of the Ganzhe Chemical Industry Plant in Jiangmen was a Polish tuidonglu paiguolu [2236 0520 3619 2226 6938 3619] refitted in 1971. This boiler operated from December 1971 to the end of 1981, an accumulated operating time of 46,691 hours. Since 1978, the accumulated operating time was 5,155-6,592 hours, with a longest continuous operating time of 120 days from May to September 1979, when it reached 2,909 hours. When the thermal value of combustion was about 3,000 kc/kg, the boiler's thermal efficiency reached 79.22 percent. The Shanghai Generating Equipment Design Institute and the Dongfang Boiler Plant carried out a series of experimental research tasks on this boiler. They obtained much beneficial experience in mastering divided bed ignition technology, immersion rod corrosion prevention technology, boiler water circulation characteristics, boiler automated control, and improving thermal efficiency.

The several fluidized combustion boilers of the Yongrong Mining Bureau's power plant use xizhongmei [3156 0022 3561] and xigan [3156 1632] and both can operate continuously for long periods. When burning 4,000kc/kg xizhongmei, boiler thermal efficiency is 78.2-80.5 percent. Such experimental research as fluidized state ignition start up, bo [2330] coal secondary ventilation experiments, buried tube heat transfer experiments, and fluidized-bed superheater characteristics have been carried out on this boiler. On the basis of this research, the Dongfang Boiler Plant designed and manufactured a 35t/h fluidized combustion boiler and installed it in the power plant.

B. Developing new boilers and applying fluidized combustion technology

The Shanghai Generating Equipment Design Institute carried out experimental research on a series of cold and hot state test devices and industrial fluidized combustion boilers and on this basis together with the Shanghai Boiler Plant designed a 35t/h and 130t/h fluidized combustion boiler for power station use. These two boilers were manufactured by the Shanghai Boiler Plant and installed in the Yiyang Oil- and Coal-fired Power Plant and the Jixi Mining Bureau's Didao Power Plant, respectively.

Yiyang's 35t/h fluidized combustion boiler began ignition tests in March 1978, in 1980 it was in normal operation, and by January 1982 its accumulated operating time was 6,190 hours, it burned 900kc/kg local bone coal, boiler thermal efficiency reached the designed value of 62.2 percent, in November and December 1980 it operated continuously for 1,126 hours. In March 1982 it passed ministry-level technical appraisal.

Jixi's two 130t/h fluidized combustion boilers went into operation in September 1979 and March 1981; by June 1984 both boilers had accumulated an operating time of 26,949 hours, had generated a total of 440 million kWh, and burned 1.6 million tons of washed coal ore. When burning low-thermal value 1,800kc/kg washed coal gangue, the boiler's thermal efficiency can reach 70.01-72.14 percent. A single continuous operation reached 1.346 hours. In October 1984 it passed ministry-level technical appraisal.

C. Promote applications and imporve fluidized combustion technology.

On the basis of summarizing existing power plant fluidized combustion boilers, the Jiangxi Boiler Plant produced two 35t/h fluidized combustion boilers and installed them in the Pingxiang Mining Bureau's Gaokeng Power Plant. They went into operation in April and October 1982, and by 1984 the accumulated single machine operating time was 27,616 hours and gross volume of electricity generated was 160 million kWh. They burned low-grade thermal value 1,560 kc/kg coal gangue, and boiler thermal efficiency reached 71.39 percent. The annual accumulated hours of operation increased from 2,168 hours in 1982 and 4,768 hours in 1983 to 6,502 hours in 1984. The one time continuous operation was 1,474 hours. In May 1983 it passed ministry-level product appraisal. At the end of 1984 this plant had burned a total of 468 million tons of coal gangue. Economic benefits increased steadily and the 1984 profit was 1.3 million yuan.

Electricity and coal are both in short supply in China and adopting low-quality fuels to generate electricity to develop industrial and agricultural production

has already become national policy. On a current basis, power plant fluidized combustion boilers still should be vigorously expanded, and relevant institutions of higher learning and scientific research units have invested more manpower and materiel to carry out developmental research, relevant boiler plants are now carrying out research and development of new model fluidized combustion boilers which are becoming serial products to satisfy needs in many areas.

II. Some Key Technological Problems Which Are Being Solved

Fluidized combustion can imporve combustion and heat transfer, adaptability to various types of coal is good and it can desulphurize and lower nitre to reduce air pollution. And it is the promotion of just these advantages that is rapidly developing. However, to use the fluidized combustion method in power station boilers introduces a series of new problems in design configuration, operations control, dust removal, abrasion protection, combustion efficiency and calculation methods. For the past few years, with the organization and coordination of the state, scientific research, design, manufacture, and user units working together, have obtained encouraging progress and there have been improvements in the performance and level of fluidized combustion boilers.

A. Characteristics of fluidized-bed layout

The fluidized bed is the key component of fluidized combustion boilers. The task of the fluidized-bed structural layout is to make the fuel burn in a stable and fluid fashion inside it. Within the bed there are suitable heated surfaces to maintain fluidized-bed temperatures so that the boiler reaches the output power demanded and operates economically and safely.

As boiler capacity increased, the bed cross-section almost increased proportionally. This is because fluidized combustion demands that the velocity of upward air flow within the bed and the thermal intensity of the bed cross-section be controlled at suitable values. Hence, large capacity power station fluisized combustion boilers frequently use separate bed layout, i.e., the entire bed surface is divided into a certain number of small-area separate beds so that the bed material flows evenly. Furthermore, the separate beds have independent air feed systems, stoking systems, and cinder elimination systems to facilitate separate bed damping when starting up separate beds and at low load.

The 35t/h and 130t/h fluidized combustion boilers both use this layout and practice proves that this is successful. The air feed system uses an isobaric air chamber and hood-type air distribution grid. The structure is simple, air distribution is even, operation is reliable, and it is widely used. New types of air guides are being researched to reduce further air feed system resistance and save on blower electricity consumption. For example, the air distribution grid designed by Hunan University has the advantages of orifice plate and hood. Air plate resistance is low, it is difficult to overheat the ring and easy to remove cinders, and it uses a modular method to facilitate serialization and simplify installation. It has been tested in a 6-10t/h fluidized combustion boiler and has passed technical appraisal. In another example the Huazhong Engineering College has researched the aerodynamic characteristics of a guide

grid attached to the back of a hood-type air distriubtion plate. Adding the guide grid can imporve fluidized quality, improve the turbulence and mixing of coarse grains at the bottom, imporve heat exchange and matter exchange, and is beneficial for combustion and complete combustion; it can be suitable for lowering operating air speed, reducing fly ash volume and fly ash carbon content; it does not have a big influence on air plate resistance characteristics and critical fuel level velocity. Hot state operation tests proved that it can achieve the anticipated results.

The normal pressure screw stoking method which is currently widely used is feasible and can satisfy the stoking demands of large capacity electric power plant fluidized combustion boilers. This stoking method is used in both 35t/h and 130t/h fluidized combustion boilers. The defect is that blade abrasion is severe and the partial lack of oxygen due to the concentration of stoking volume which affects combustion. Countermeasures which have been adopted are to weld abrasion-resistant material to the places on the screw blades which are easily abraded, adding a coal distribution air current at the stoking inlet and accelerating coal particle distribution and supplementing the oxygen. For the results see Figure 1: When there is no coal distribution air current the CO content exhibits a straight line drop from the coal inlet to the center of the bed, after adding a coal distribution air current the CO peak values at the stoking inlet disappear, the CO content levels decline greatly and distribution is more even. After adding a coal distribution air current, the bed temperature at the stoking inlet rose from 700-750°C to about 900°C and promoted ignition and combustion of the coal entering the furnace.

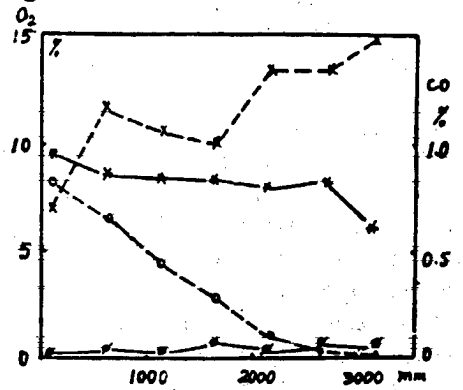


Figure 1. Impact of addition of air distribution current on gaseous elements in the bed

...x...O_2 (without current); -o-O_2 (with air current)
...x...CO (without current); -o-CO (with air current)

In terms of stoking methods, the Harbin Industrial University and other units, on the basis of summarizing practical experience, adopted a method of stoking by dropping coal from the coal feed tube in normal pressure of the fluidized-bed then used air currents to blow it into the bed. This both avoided the problem of complexity of the screw stoker structure and easy abrasion, and also has the advantages of the coal distribution air current. This has already been successfully operated in small-scale fluidized combustion boilers and is a stoking method with a good future.

Cinder removal systems currently mostly use such methods as continuous cinder removal through an overflow mouth, and periodic emission of large grains in the bottom of the bed by a cold cinder tube. It is then carried away by such mechanical methods as flushing with water or by truck. The Jiangmen Chemical Industry Plant and other units have used automatic control of bed material height which automatically removes cold cinders.

Air and water-cooled cinder coolers have been put into operation to use the physical heat of high temperature ash and cinders to lower the q loss. This can lower cinder temperatures from 900°C to 200-300°C. Some higher schools and scientific research units are researching new types of cinder coolers to be applied to large-capacity boilers and have obtained improved benefits.

B. Measures to improve combustion efficiency

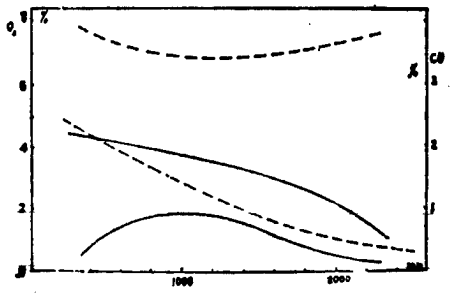
Since power plant fluidized combustion boilers use broad screened coal grains, fine grains smaller than 1mm in the stoking and which are not burned are carried up away from the fluidized layer by the rising smoke; some larger coal grains which have not completely burned are also carried upward in the trailing vortex of gas bubbles and at the fluidized layer interface as the gas bubbles burst and spatter. In line with current crusher and sieving systems, fine coal powder smaller than 1mm in the stoking coal should make up 1/3-2/5 of the volume of stoking coal, and the carbon content is also higher and this is the primary factor in combustion efficiency. The thermal loss due to mechanical incomplete combustion in the ash and cinders by 0.2-0.5mm fly ash is most severe. Thus, how to transform the structure to improve its combustion efficiency is very important

Lower fluidized velocities and suspension stage smoke flow velocities should be used to reduce thermal loss of mechanical incomplete combustion caused by escape of fine powder. That is, expand the cross-section area of the fluidized-bed and the furnace chamber appropriately. On the basis of the demand for thermal balance within the bed and while ensuring the fluidized quality, arranging sloping buried tubes in the bed can play an obstructing role with regard to the escape of fine powder.

For burning coal which has a great deal of fine powder and high volatility content, in addition to adding a coal distribution air current at the stoker inlet, a secondary air current is added at the suspension section inlet to encourage secondary combustion. The results are as indicated in Figure 2. When a secondary air current is added the O_2 content in the flue was reduced, and without secondary air current, the CO distribution exhibited a straight line drop from the stoking side to the center of the bed, after the secondary air current was added, the overall level declined and distribution was even, and if the air current volume was larger then the peak values at 1 m could be further reduced.

To resolve the problem of large-scale scattering of wide screened coal particles in the bed, the Xi'an Thermal Engineering Institute carried out tests on a fuel-crushing--drying--air pressure sorting system at the Jiawang Power Plant which made the incoming coal go through a ventilated type reaction crusher and a houwei [0683 0143] positioned dryer tube, all the crushed material was raised

once by a pneumatic conveyer and the selection process completed. The pneumatic selection method gave the system excellent characteristics for automatic grading according to differences in grain weight. In a further hot state test, fine coal powder was transported to the bottom of the air distribution plate by wind force and the large coal grains entered from the top of the bed, thus improving the thermal efficiency of the entire fluidized-bed layout.



Length of Fluidized-bed

1-O_2 (no secondary current); 2-O_2 (with secondary current)
3-CO (no secondary current); 4-CO (with secondary current)
(The dashed curves in the figure read from top to bottom 1,2,3,4)

So that fly ash will completely burn, another "fly ash fluidized-bed" can be set up independently, using a lower fluidized air velocity so that fly ash smaller than 0.5mm will burn in the bed. This has been tested in some small-scale fluidized combustion boilers and can increase combustion efficiency by 10-15 percent.

C. Dust removal to satisfy emission requirements

China's fluidized combustion boilers burn a high-fly ash, low thermal value, poor quality coal; the volume of coal burned is large, so that the soot concentration is very high, reaching 60-80 g/standard m^3. When burning bone coal and coal gangue with high ash content over 70 percent, the concentration of soot at the fluidized combustion boiler flue can reach 110-170 g/standard m^3. Clearly, dust removal from fluidized combustion boiler smoke is very important.

The fly ash of boilers which burn good quality coal in conventional combustion methods generally is finer that 300 microns and the majority are 10-20 microns. But the range of fly ash grain width from fluidized combustion boilers is 0-1mm and has high combustible material content. Demands on dust removers are different for coal powder furnaces. Furthermore, it is very difficult to achieve national emission demands relying on dust removers external to the furnace for treating such a large quantity of fly ash. A large ash volume also created problems for the dust remover itself, such as abrasion and ash blockage. Thus even if we have stop gap measures and develop a variety of highly effective dust removers, there also should be permanent solutions, improving fuel crushing systems and equipment, furnace structure, stoking method and drying methods to arrange for better fluidized combustion to reduce the volume of fly ash which escapes.

In mine areas, coal washing plants or suitable local facilities carry out fuel crushing and sifting, and provide "coal for fluidized combustion" in accordance with the demands for caloric capacity and sieving ration, the overall economic benefits should be higher than units carrying out their own crushing and sifting, now only lowering the processing expenses of the fuel itself, but also will be advantageous for improving the fluidized combustion efficiency and lowering fly ash volume.

Dust removal inside the furnace is necessary and effective not only in small-scale fluidized combustion boilers but also in medium and large-scale fluidized combustion boilers. For example:

Cold and hot state tests conducted by Harbin Industrial University on a cyclonic barrel inside the furnace of a brown coal fluidized combustion boiler prove that the separation efficiency of the cyclonic barrel was 40-48 percent, the carbon content of the separated ash was greatly reduced, being only 0.93.1-1.76 percent.

The Yiyang petroleum and coal utilization test power plant's 35t/h fluidized combustion boiler counter-current constrains the smoke and changes its direction of flow. The customary volume of ash that is separated and settles out reach 9.2t/h, making up 63 percent of the ash volume that escapes the fluidized bed, and 70 percent of the settled ash is 0.4-1.6mm coarse ash.

A superheater counter-current smokstack high-temperature ash trap and a tail section smokestack outlet low-temperature ash trap were added to the 130t/h fluidized combustion boiler of the Jixi Mining Bureau's Didao Power Plant which was clearly effective in collecting fly ash. The high temperature ash bucket ash volume reached 4.39t/h, the lower temperature ash bucket ash volume reached 9.97t/h, accounting for 14.5 percent 33.3 percent of the ash respectively.

From the above examples it is clear that using dust removal inside the furnace can eliminate approximately half of the overall fly ash volume, greatly reduce the dust concentrations emitted by small boilers and improving the working conditions of dust removers outside the furnace.

Generally in line with the characteristics of the large volume and broad screening of fluidized combustion boiler fly ash, two levels of dust removers are used: the first level eliminates particles larger than 0.2-0.5mm and the second level eliminates powder. As to which type of dust remover should be used, that must take into consideration smoke volume, dust concentrations, sieving characteristics, resistance demands, local climatic conditions, investment and operating and maintenance expenses as well as adapting to local conditions.

The 130t/h fluidized combustion boiler uses dry dust removal system made up of an advance settling chamber and multi-tube cyclonic wind sub-group second level arranged serially. Its dust removal efficiency can reach 94.2-95 percent. The ash removal volume of the settling chamber makes up about 61 percent. The grains in the settled ash larges than 0.2mm make up about 80 percent, indicating that is has a high trap ability for large particle fly ash. In future we will continue to make improvements in structure in order to obtain better dust removal results.

D. Measures to reduce abrasion

The problem of fluidized combustion boiler abrasion is a major concern and threatens safe operation. In the initial stages, there were accidents when immersion heated surface abrasion burst the tubes. Qinghua University reported that the rate of abrasion of immersion heated surfaces (lateral tubes) in the bed reached 6.0-7.92mm/yr. Jiangmen Ganzhe Chemical Industry Plant measured the rate of abrasion of the curved part of ϕ83x4 vertical tubes at 1.0-1.2mm/thousand hours. The rate of abrasion of 57x5 horizontal tube incoming air flow surfaces reached 1.31mm/thousand hours. The cross section of an abraded tube was analyzed and the abraded surface was discovered. The most severe horizontal tube abrasion was that the rate of the lowest rank of tubes was over 4 times that of the two after tubes and the circumferential abrasion was uneven, with the most severe being incoming airflow surface area at the bottom 2/5 of the tube. This is a kind of exidation abrasion under conditions of high temperature oxidation and low velocity, large solid grain washing.

For this reason, a test of welding anti-abrasion plates to the immersion tubes in a horizontal slope arrangement was carried out at the Jiangmen Ganzhe Chemical Industry Plant. A better structural arrangement was obtained and applied in 35t/h and 130t/h fluidized combustion boilers so that the period of use exceeded 8,000 horus and the anticipated results were achieved.

In addition to the above configuration, we should also begin with abrasion resistance of materials to develop better anti-abrasion results. These materials should have oxidation resistance and wash abrasion resistance at 500-600°C and should also require sulphur corrosion resistance in sulphur-bearing atmospheres. Currently, the Ministry of Metallurgy's Iron and Steel Research Institute and the Chinese Academy of Sciences' Shenyang Metals Institute are carrying out experimental research.

Attention should also be devoted to abrasion of heated surfaces. This is due to the flow of smoke containing dust concentrations as high as 100-200gr/standard m^3 (general coal dust furnaces are only 15-35gr/standard m^3) over convection heated surfaces and grains with large diameters and sharp angles increase tube abrasion, thus low smoke velocities (less than 8m/sec) should be used, anti-abrasion plates should be added to incoming airflow surfaces, and tube layout should check the smoke corridor all of which should be considered in the light of fluidized combustion characteristics and at the same time, dust removal inside the furnaces should be adopted.

One thing worth mentioning is the abrasion caused by leaks in the tube-type air preheaters. Since fluidized combustion requires that high-pressure air be introduced to overcome the resistance of the bed materials and fluidize it, the pressure differential between the air in the air preheater and the smoke is very large. If there are leaks between the tubes and the tube plates in the preheater, between the tube box and the supports or in the expansion joints, the high velocity air which escapes picks up smoke with high dust concentrations and can cause severe abrasion of the tube plate and tubes in the preheater. Therefore, in the design, manufacture and installation process, corresponding structural measures should be adopted in the light of this characteristic.

In addition, there is severe abrasion of cursher hammers, stoker blades, cinder pump impellers, and air intake vanes. Although periodic replacement can maintain production, the main tenance expenses are high. Thus, development of abrasion resistant materials suited for use in these components has become a topic for research and experimentation, and has achieved anticipated results in laboratory tests and awiats trials in long-term industrial tests.

Abrasion of furnace walls in the fluidized combustion bed protion is severe. After 3,000 hours of operation where abrasion is severe, the high alumina brick was abraded over 100mm. The unevenness of the abrasion is a function primarily of collision and scraping abrasion accompanied by corrosion. Another cause is damage caused by particles striking the furnace walls when gas bubbles burst at the interface. The degree of damage is determined by the size of the particles and their velocity. To resolve this problem, the Tangshan Branch of the Coal Sciences Institute has developed a high alumina brick with an abrasion resistant layer. After 3,000 hours of tests in an actual furnace, the ordinary high alumina brick was abraded 40-60mm, the surface was pitted and in some areas it reached 90-100mm. But the abrasion resistant layer of the test brick was abraded only 1-2mm, the surface was smooth, and there cracks only in places with abrasion reaching 3-5mm. It awaits further research to improve abrasion resistance performance.

III. Problems Worthy of Further Exploration and Research

In order to further improve the performance and level of existing power station fluidized combustion boilers and develop power station fluidized combustion boilers with larger capacities and suited to different types of coal, there are still many problems in theory and applications technology which need to be researched in depth. For example the following:

A. Exploration of methods of calculating thermal power

There is not yet any generally accepted method of calculating the thermal power of power station fluidized combustion boilers. The existing boilers use the thermal calculation standards for coal furnaces and some experimental data, but in practice it has been discovered that there are more heated surfaces and the air temperature tends to be high and the 35t/h and 130t/h furnaces cuts out for the most part the superheater tubes and the immersion tubes in the bed.

Through research on mechanisms and industrial tests the thermal transmission coefficient of the heated surfaces in the fluidized-bed, combustion portion of the fluidized-bed, pollution coefficient of convection heated surfaces, and the method of calculating fluidized beds and suspension section should be determined. And calculation programs could be written.

B. Automatic control of power station fluidized combustion boilers

Power station fluidized combustion boilers which are currently operating are at the level of manual remote control. Only individual items such as bed temperature and bed material height are automatically controlled in some surfaces. Systematic experimental research of fluidized combustion boiler operation

performance and dynamic characteristics should be carried out to obtain mathematical models of dynamic characteristics to write a control program. The boiler control systems, centralized operations monitoring system developed can realize open and closed loop automatic safety control of power station fluidized combustion boilers.

C. Experimental Research on high-speed circulating beds

Some universities have set up test sites and are carrying out research on the mechanisms. This new type of fluidized-bed has the advantages of high combustion efficiency and is easy for large scale development and has a great future. In the past few years there has been much research on this abroad.

D. Experimental research on fluidized bad desulphurizing

The proportion of high sulphur coal in the coal China mines is increasing. Fluidized combustion boilers can desulphurize in the bed to reduce SO_2 pollution of the atmosphere, can burn high sulphur coal and this is an important goal abroad in developing fluidized combustion boilers. In the past only a few units in CHina has undertaken research in this area and in the future work in this area should be intensified to satisfy the need for large capacity fluidized combustion boilers to burn high sulphur coal.

E. Complete sets of auxiliary machinery for power stations

For some special auxiliary machinery for fluidized combustion boilers, such as crushing and sieving equipment for coal supply system, cinder removal equipment, cinder coolers, and dust removers in cinder systems; and blowers and exhaust fans of the ventilation systems existing products are used indiscriminately, there is low efficiency and there are problems with high power consumption and serious abrasion. This should be made a research topic and speicalized plants designation for production.

8226/12232
CSO: 4008/40

SPEEDING UP DEVELOPMENT ON UPPER REACHES OF HUANG HE

Beijing SHULI FADIAN [WATER POWER] in Chinese No 12, 12 Dec 86 pp 3-5

[Article by Survey Group for Hydropower Economic Development on the Upper Reaches of the Huang He[1]: "A Proposal To Accelerate Comprehensive Hydropower Development on the Upper Reaches of the Huang He"]

[Text] Our survey group was jointly composed by the Chinese Land Ecomomics Research Society, the China Hydroelectric Engineering Society, and the China Water Conservancy Economics Research Society and was made up of 46 members including leaders, specialists, professors, reporters, and workers in water conservancy and hydroelectric power from relevant units and representatives from Qinghai, Gansu, and Ningxia. The aim of the survey was to accelerate the comprehensive development of water energy resources on the upper reaches of the Huang He and explore reform measures for development in order to promote the development of the economy of the northwest. From 10 July to 4 August 1986 we surveyed sites on which hydroelectric power stations has been built, were under construction, or were planned on the section of the upper reaches of the Huang He from Longyangxia to Qingtongxia (abbreviated "Long-Qing" section) and related factories, water conservancy and irrigation projects and irrigation areas; at the same time we heard reports from relevant departments of Qinghai, Gansu, and Ningxia and exchanged views with party and government leaders of these areas. After survey and discussion we feel that the water energy resources of the upper reaches of the Huang He are truly a "mother lode" worthy of the name, that the economic and social benefits of the hydroelectric power stations already constructed are large and the development conditions for hydroelectric power stations yet to be constructed are excellent. Thus, we propose that as quickly as possible the state adopt policies to accelerate development, adopt reform measures, establish an Upper Reaches of the Huang He Hydroelectric Joint Development Company and strive to complete construction of hydroelectric power stations in the Long-Qing section by about the year 2000. Our main views and proposals are as follows:

I. The Policy for Hydroelectric Power Stations Already Constructed on the Upper Reaches of the Huang He Is Correct and the Economic Benefits Obvious

The Long-Qing section of the upper reaches of the Huang He is 1,023 km long, the overall drop is 1,465m, it has a total of 14 or 15 cascade hydroelectric power stations (the development of one or two levels on the Heishanxia section is not yet determined), with a rated capacity of 13.696 million kW.

Qian said dam construction in China faces problems because of narrow valleys, huge discharges, high silt content and frequent earthquakes. Many hydropower stations are located in remote areas where there is no easy access. This causes additional difficulties in construction, river diversion, flood discharge and layout of dam structures.

China's water resources, mainly in southeast and southwest China, totals 2,700 billion cubic meters. There are 1,500 rivers with drainage areas exceeding 1,000 square kilometers each. These include the [Chang Jiang, the Huang He and Zhu He] rivers.

Qian said authorities are facing difficult problems in controlling floods in the rivers, especially in the lower reaches of the [Huang He] which contains much silt.

Existing dikes and embankments in China are as long as 179,000 kilometers. There are also 88,000 reservoirs, with a total storage capacity of 420 billion cubic meters, which can be used to help regulate rivers when floods occur.

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CAPACITY TO REACH 80,000MW BY YEAR 2000

HK230215 Beijing CHINA DAILY in English 23 May 87 p 1

[Article by staff reporter Xu Yuanchao]

[Text] The capacity of hydropower stations throughout China is expected to increase to 80,000 megawatts by the end of the century from the current 27,680 megawatts, Qian Zhengying, minister of water resources and electric power, said yesterday.

Construction of 27 large and medium sized hydropower stations is now underway. The total capacity will be 15,000 megawatts, Qian told the 55th executive meeting of the International Commission on Large Dams, which opened in Beijing yesterday.

She said China has rich hydropower resources. Theoretically, the potential of the resources is 667 million kilowatts, of which 368 million kilowatts can be developed.

Over the past 38 years, Qian said, China has built 18,595 dams which are higher than 15 meters. Most of them are earth dams. There are 100 dams which exceed 60 meters in height.

But the country's hydroelectric production still cannot meet the increasing demand for energy. The ministry will build more dams in the next few years to keep pace with development of the national economy.

One dam to be built will be the Three Gorges Dam on the Yangtze River in Hubei Province with a height ranging from 165 to 175 meters. The total capacity will be 13,000 to 17,000 megawatts. But Qian said the design is being discussed among experts.

Other dams will include the 245-meter-high Ertan dam in Sichuan Province, the 240-meter Goupitan dam, the 216-meter Longtan dam in Guangxi Zhuang Autonomous Region, and the 180-meter Tianshengqiao rock-fill dam in Guizhou Province.

Included are four water conservancy and hydroelectric power projects which have already been constructed: Liujiaxia, Yanguoxia, Bapanxia, and Qingtongxia. The total investment in these four hydroelectric power stations was 1.2 billion yuan, total rated capacity is 1,964,000 kW, including investment in multipurpose functions such as irrigation and flood prevention. The average annual investment per kilowatt is only 626 yuan, cheaper than the average annual investment per kilowatt of 631 yuan of the Xigu, Yongchang, and Liancheng thermal power plants which were built in the same period in Gansu. By the end of 1986 the cumultative volume of electricity generated was 121.8 billion kWh, the gross value of output was 7.9 billion yuan, and 5.47 billion yuan had been handed over to the state as taxes and profits, which was 4.4 times the gross investment in the four power stations; a large volume of funds was accumulated for the state and the equivalent of 6,700 tons of coal saved.

The four hydroelectric power stations which have already been constructed are the mainstay power stations of the Northwest Power Grid and for the past 20 years and more not only have provided sufficient and economical electric power for industrial production, especially ferrous metals refining, petrochemical industry, iron alloys, carbon and for development of high-lift pumping for irrigation for the four northwest provinces (regions) but have also provided at the right time and in the right quantities water for irrigation of the original 10 million mu of farmland and over 4 million mu of newly irrigated farmland, basically resolved the problem of flooding and ice on the upper reaches of the Huang He, guaranteed the safety of the lives and property of the people on both banks of the river and an unimpeded rail link from Baotou to Lanzhou, and made a contribution to the development of the economies of Gansu, Ningxia, and Inner Mongolia. The social and economic benefits of power generation are obvious.

II. Accelerate the Development of Hydroelectric Power on the Upper Reaches of the Huang He, Promote the Development of Industry and Agriculture in the Northwest, and Prepare for China's Strategic Shift in the Beginning of the 21st Century.

There are 9 or 10 hydroelectric power stations awaiting construction on the upper reaches of the Huang He with [a total] rated capacity of 10,452,000 kW and compared with hydroelectric power stations nationally they have the following outstanding advantages: (1) Regulation by three large reservoirs at the head, middle, and tail of the river section can permit the water resources to be utilized quite rationally. Regulation of the reservoir yet to be built at Longyangxia and the reservoir already constructed at Liujiaxia in particular can improve power generating benefits so that the hydroelectric power stations already built and yet to be built can generate electricity evenly year-around. The power generating capacity is basically the same in an ordinary year's flood season and dry season, thus the quality of electricity is the best in the country; at the same time it can also cut down the rate of flow of floods reducing the construction costs of power stations awaiting construction and shorten the construction time. (2) It can expand the irrigated area over 10 million mu and eliminate the threat of floods and ice in the Gansu, Ningxia, and Inner Mongolia regions, thus the overall benefits are

are considerable. (3) The land of the nomads inundated per rated kilowatt is only 3 percent of the national average and there are few difficulties in arranging for nomads; the volume of concrete work required per kilowatt is 60 percent of the national average; the investment per kilowatt is about two-thirds of the national average, therefore, the technological and economic indicators are excellent. (4) The hydroelectric power stations built on the upper reaches of the Huang He have accumulated an abundance of experience, preliminary survey and design work is well grounded, and there are the design reserves of the power stations at Lijiaxia and Daxia which can fill the need for rapid development.

In 1983, the leading comrades of the Central Committee stated the strategic deployment of economic development that "at the end of this century and the beginning of the next century, the focus in China's economic development must shift to the great northwest." To realize this strategic shift, water, energy, communications, and agriculture must start first. This is laying the foundation, water energy resources of the upper reaches of the Huang He is the major superiority of the northwest and developing it can gradually satisfy the demands of creating the basic conditions mentioned above. Developing this hydroelectric power of over 10,000,000 kW, its rated capacity will be about three-fourths of the increased rating of the northwest power network in the year 2000. Qinghai, Gansu, and Ningxia have abundant ferrous metals, salt chemistry industry, and coal resources and developing these high quality, low-cost water energy resources as quickly as possible will be useful for developing high electricity-consuming industries such as aluminum, nickel, copper, magnesium, and lead-zinc and iron alloys, further developing production of fertilizer and processing-intensive raw materials of the petrochemical industry and nonferrous metals can bring about rapid development of the economy of the northwest and create conditions for readjusting China's high energy-consuming industries. In accelerating the development of upper reaches of the Huang He, hydroelectric power can also supply water for use in the Qinghai, Gansu, Ningxia, Inner Mongolia, and the upper reaches of the Huang He and Shaanxi regions to develop further water conservancy irrigation in these areas, improve the ecological environment and thoroughly resolve problems of flooding and ice in the Gansu, Ningxia, and Inner Mongolia areas. It can help the peoples of the northwest rapidly cast off poverty and become rich and reduce the gap between the northwest and the economically developed regions of the country.

Accelerating the development of hydroelectric power on the upper reaches of the Huang He can fully exploit the superiority of the reservoirs on the upper reaches of the Huang He for multiple year regulation, promote creation of a Northwest-North China and Northwest-Southwest (Sichuan) integrated power grid, carry out compensatory regulation between hydroelectic and thermal power and the unregulated performance of hydroelectic power stations so that the potential of the hydroelectric power stations so that the potential of the hydroelectric and thermal power facilities of the three major power networks can be developed, alleviating such problems as difficulties with thermal power peaks in North China, shortages of power in especially dry years in the northwest and loss of large quantities of water during flood seasons in Sichuan and severe inadequacy of electric power in dry seasons.

In short, accelerating development of the upper reaches of the Huang He electric power is of strategic importance for the economic development of the northwest and China's strategic economic shift at the beginning of the 21st century.

III. Reform Hydroelectric Power Construction Management System, Establish Joint Upper Reaches of the Huang He Hydroelectric Power Development Company

As the current hydroelectric power construction management system is not suited to the new situation of accelerating the development of hydroelectric power, a solution must be sought through reform. After full deliberation and discussion by the Survey Group and exchanges of views with party and government leaders of Qinghai, Gansu, and Ningxia, everyone agreed to the establishment of a joint upper reaches of the Huang He hydrolectric power development company. The specific proposals are as follows:

1. The Joint Upper Reaches of the Huang He Hydroelectric Power Company will be "an independent administration, a commercial producer and administration responsible for its own profit and loss, have the capacity for self-reform and self-development, become a legal entity with definite rights and responsibilities"--an economic entity with multi-faceted alliances.

2. The company's task is: To strive to complete in 15 years the development of the 9 or 10 hydroelectric power stations awaiting construction on the upper reaches of the Huang He, acquire a rated capacity of over 10,000,000 kW and quantity of electricity of 33,000,000,000 kWh to support the economic construction of the northwest.

3. Primary measures are : (1) adopting cascade continuous construction to carry out the flow process of construction of 3-4 hydroelectric power stations. The company is responsible for such work as initiating invitation of tenders and contracting and striving to shorten the power generation construction period for the large-scale hydroelectric power station main body to 3-5 years. (2) Break through boundaries between industry, department, and region, intensify lateral alliances, create more channels for raising money (locally they can include funds used for building roads, labor, and nomad resettlement, issue stocks or bonds, and use of foreign capital), mobilize the initiative of departments, local areas, enterprises, and individually operated power facilities to reduce investment included in state-mandated planning.

4. To realize these tasks, the state must grant the company definite rights and stipulate rational economic policies: (1) Grant development rights and administrative rights on the Long-Qing section of the upper reaches of the Huang He. (2) The state will make available 800-900 yuan per kilowatt of rated capacity (not including funds for high tension lines), the company will contract to construct and the shortage will be raised by the company (preliminary estimates are that in addition to the 700 million yuan necessary to continue to satisfy construction of Longyangxia, the state must appropriate 800-900 million yuan in the Seventh Five-Year Plan and 3-5 billion

yuan in the Eighth Five-Year Plan). (3) Implementing the policy of "using hydrolectric power to generate hydroelectric power," the Longyangxia hydroelectric power station will be transferred to the administration of the company and except for the product taxes paid, all income will be retained as supplementary funds for power stations to be constructed on the upper reaches of the Huang He. (4) Hydroelectric power stations should be treated as one time energy sources and a policy of low interest, suitably long loan replayment schedules should be implemented and except for Longyangxia, plan to repay the loan and interest to the state within 15 years of each hydroelectric power station going into operation. After all cascade power stations have been completed, the loan for the Longyangxia power station will be repaid. (5) The investment in the multipurpose portion should be shared sensibly, for example, the state should grant low interest loans for investment used for water conservancy. (6) Taking into account the influence of repaying principal and interest after electric power investment of funds on electric prices, there should be an increase in the company's prices for wholesale electricity (on the basis of the specific situation in the upper reaches of the Huang He, in terms of wholesale price of electricity provided by the company to electric power networks in 1985 as a constant price, this would be approximately 6 cents per kWh.) (7) The relationship between the company and the power grid is that electricity will be sold to the power grid by economic contract and will obey unified control of the power grid in order to achieve optimum economic benefits for joint operation of hydroelectric and thermal power.

The State Planning Commission should take the lead in the proposed company and with Qinghai, Gansu, and Ningxia and representatives of the Ministry of Water Resources and Electric Power form a board of directors or leadership team and implement a general management responsibility system.

We firmly believe that with the support of the Central Committee and active participation of local areas in implementing reform, the development of the water energy resources of the upper reaches of the Huang He is bound to blaze a new path of rapid turnaround of funds, shorter construction time, and greater economic benefits.

FOOTNOTES

1. The members of the Survey Group on Hydropower Economic Development on the Upper Reaches of the Huang He: Group leader--Lin Hua [2651 5478], Deputy Head of the Station Planning Commission's Consultant Group and former Deputy Director of the State Planning Commission; Deputy group leader: Qian Sichao [6929 1835 3390], Deputy Director of the China Hydroelectric Engineering Society, Deputy Director of the Ministry of Water Resources and Electric Power, Member of the State Planning Commission's Consultant Group, and former Director of the State Planning Commission's Randong [3595 0520; literally "fuel power"] Group; Secretary--Liang Yihua [2733 4135 5478], Deputy Director of the China Water Conservancy Economic Institute and Deputy Director of the China Hydroelectric Engineering Society, and Survey Group members Yang Shouzheng [2799 1343 2973], Liu Zhaolun [0491 0340 0243], Zhang Tiezheng [1728 6993 6927], Lei Shuxuan [7191 2885 5503], and others for a total of 46 persons.

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DEVELOPING UPPER HUANG HE TO SUPPORT NATION'S ECONOMIC GROWTH

Beijing SHUILI FADIAN [WATER POWER] in Chinese No 12, 12 Dec 86 pp 6-13

[Article by Shi Ruifang [4258 3843 5364] and Wang Jingwen [8001 2529 2429], Northwest Survey Design Academy, Ministry of Water Resources and Electric Power: "Speeding Up Hydropower Development on the Upper Reaches of the Huang He To Greet the Strategic Shift of the Focus of China's Economic Development"]

[Excerpts] In 1983, leading comrades of the Party Central Committee stated: "By the end of this century and the beginning of the next century, the focus of China's economic development must shift to the great northwest." To realize this strategic shift, water, energy resources, communications, and agriculture must come first. The water energy resources of the upper reaches of Huang He are one of the "motherlodes" of China's hydroelectric power, developing advantageous conditions and accelerating the development of this hydroelectric power can provide low-cost, non-polluting electricity and ample water resources for northwest industry and agriculture and make preparations for the strategic shift in the focus of China's development

I. Viewed From the Perspective of the Social and Economic Benefits of Hydroelectric Power Stations Already Constructed or Under Construction, the Water Power Resources of the Upper Reaches of Huang He are definitely a "Motherlode" of High-quality, Low-cost Hydroelectric Power.

Since the founding of the People's Republic of China, China has constructed water conservancy and hydroelectric power projects at Yanguoxia, Liujiaxia, Qingtongxia, and Bapanxia on the upper reaches of the Huang He and the Longyangxia hydrolectric power station is currently under accelerated construction. From the perspective of the water conservancy and hydroelectric power projects already constructed or under construction, the economic and social benefits are very clear and prove that the water energy resources of the upper reaches of the Huang He are indeed a "motherlode" of high-quality, low-cost hydroelectric power.

The overall rated capacity of the four hydroelectric power stations already constructed is 1.964 million kW, the gross investment, including investment in generating electricity, irrigation, and flood prevention, is 1.229 billion

yuan, lowering the investment per kilowatt for 626 yuan. The average investment per kilowatt of the hydroelectric power station at Liujiaxia, Yanguoxia, and Bapanxia in Gansu is only 569 yuan, and if the investment in comprehensive utilization is shared, the the investment per kilowatt drops to 503.55 yuan, which is lower than the 631 yuan in investment per unit of the thermal power plants constructed at Xigu, Yongcheng, and Liancheng in Gansu (deducting the shared investment for heat supply by Xigu). From the Yanguoxia power station constructed earliest which went into operation in November 1961, to the end of 1985, the cumulative capacity of the four power stations was 121,808,000,000 kWh, the gross value of output was 7.918 billion yuan, and the cumulative taxes and profit provided was 5.469 billion yuan, or 4.4-times the gross investment. The 121,808,000,000 kWh of electricity is equivalent to a saving of 67 million tons of coal, and equivalent to the investment in the annual production and corresponding transportation of 5 million tons of coal. It is estimated that 50 years after the four hydroelectric power stations go into production, they will have generated approximately 410,000,000,000 kWh, gross accumulation will reach 18.065 billion yuan, which is 14.7-fold the investment. The next profit per kilowatt of the hydroelectric power stations at Liujiaxia, Yanguoxia, and Bapanxia with in the borders of Gansu is 4,231.81 yuan more than the net profit per kilowatt of the thermal power units calculated according to static estimated.

The overall rated capacity of the four hydroelectric power stations is 37 percent of the overall rating of the Shaanxi-Gansu-Qinghai-Ningxia power grid in 1985. They are the mainstay power stations in the grid, have undertaken the entire task of peak regulation, frequency regulation, and most of accident reserves so that the thermal power in the grid can generate electricity uniformly and at high efficiency and make the Shaanxi-Gansu-Qinghai-Ningsia power grid's technical and economic norms rank as national spearheads and make a contribution to safe and economical operation nationwide.

The rate capacity of the four hydroelectric power stations which makes up 63 percent of the rated capacity of Qinghai, Gansu, and Ningxia is the primary source of electricity for industrial and agricultural production in the three provinces (regions), especially the 200 million yuan of electricity expenses given preferential treatment every year for nonferrous metals smelting, petro-chemical industry, iron alloys and water lifting for irrigation which promoted the high speed development of these industries and agriculture.

In addition to enormous electricity generating benefits, these four hydroelectric power stations also have clear multipurpose benefits for irrigation, flood prevention, ice prevention, municipal and industrial water, fisheries, and tourism:

1. Irrigation Benefits

Since the Liujiaxia reservoir was built, in June and July of every year it holds 800-1,200 million m^3 storage capacity for supplementary water for irrigating the lower reaches so that the irrigated area of Gansu, Ningxia, and Inner Mongolia reached 14-16 million mu, expanding the area by 3.36-6 million mu, increasing food production by about 1.5 million tons. In Gansu,

irrigation was expanded by over 1 million mu and food production was increased by 250,000 tons. In Ningxia, irrigation was expanded .5-2.18 million mu and food production was increased by 650,000 tons. In Inner Mongolia, irrigation was expanded by 1.86-2.6 million mu and food production was increased by 600,000 tons. The expanded irrigation area described above includes the expanded irrigation area of Yanguoxia, Bapanxia, and Qingtongxia after 1968, but does not include their expanded irrigation area before 1968, especially the irrigation benefits of Qingtongxia in 1960 which concluded the history of damless water diversion, reduced the volume of annual maintenance and developed a large irrigated area.

2. Flood prevention benefits

The Liujiaxia reservoir accepted the task of flood prevention on the lower reaches so that the hundred-year event peak flood flow at Lanzhou wasreduced from 8,080 m^3/s to the safe sluice volume at Lanzhou of 6,500 m^3/s, basically eliminating Huang He floods, especially the flood which occurred on the upper reaches of the Huang He in September 1981 and was the biggest since records have been kept. The maximum peak flow volume at the Lanzhou cross section was 7,000 m^3/s, which exceeded the safe sluice volume. Because of the regulatory storage of the Longyangxia dam and the Liujiaxia reservoir, the maximum flow at Lanzhou was only 5,600 m^3, 1,400 m^3/s below the peak and delayed the time when the maximum sluice volume appeared by 5-6 days, buying time for flood prevention emergency measures on the lower reaches and ensuring the safety of the lives and property of the people on both banks of the Huang He and unimpeded traffic on the Baotou-Lanzhou railway. If there had not been any regulation by the Longyangxia dam and the Liujiaxia reservoir at the time, Lanzhou city area and the banks would have been inundated; a major flood similar to the one which occurred in 1904 in Ningxia is estimated to inundate up to 800,000 mu and would seriously endanger the safety of 7.266 million mu, 1.363 million people, and the trunk canal of Sanshenggong in 13 counties and banners in Inner Mongolia, and at the same time, the only railroad linking the interior with the northwest--the Baotou-to-Lanzhou Railroad (at the time the Longhai Railroad had already been cut off by the flood) --also would be damaged and the social and economic losses created would be extremely serious.

3. Ice prevention benefits

After the Huang He flows from west to east to Lanzhou, it bends toward the northwest so that the latitude of the lower reaches is higher than that of the upper reaches and the air temperature is thus lower than the upper reaches. After March, the flood water of ice-melt in the Lanzhou channel flows to Ningxia and Inner Mongolia where the river is still frozen shut thus the large quantity raises the water level and forms an ice dam causing the river to overflow its dikes and creating a ice disaster. According to statistics, in the 32 years from 1951 to 1983 there was a total of 287 ice dams, 267 of which, or 93 percent of the ice dams, were between 1951 and 1968 (before the Liujiaxia reservoir went into operation), losses due to the river being unopened occurred on average once every 2 years; in the 18 years after Liujiaxia went into operation, in the ice prevention period the sluice

volume is reduced so that the average flow at Lanzhou does not exceed 500 m^3/s, there have only been five small scale ice-run disasters.

From the above it can be seen that the power generating benefits and the social benefits of the four hydroelectric power stations that have already been constructed are really very clear. Let us now take another look at the economic benefits of the Longyangxia hydroelectric power station which is under construction.

The Longyangxia hydroelectric power station began storing water in October of this year [1986] and two generators are slated to begin generating electricity next year [1987]. The investment approved for the Longyangxia power station is 1.769 billion yuan (investment for some additional projects has yet to be approved. The rated capacity of the power station is 1,280,000 kW, guaranteed output power is 589,800 kW, annual generating volume close to 6 billion kWh, and it can provide nearly 300 million yuan in taxes and profits per year. Since Longyangxia has a gross storage capacity of 24.7 billion m^3, and an effective storage capacity of 19.35 billion m^3, and serving as the "spigot" for this section of the river controlling the head of each cascade on the lower reaches, the reservoir energy storage ability is greater, currently approximately 8 billion kWh, long-range 43 billion kWh, it is the largest power storage reservoir in China in this century. Through compensatory regulation of Longyangxia, the guaranteed output power of 254,800 kW of the Liujiaxia, Yanguoxia, Bapanxia, and Qingtongxia hydroelectric power stations already constructed on the upper reaches of the Huang He can be improved, increase the annual power output 513,000,000 kWh and can improve guaranteed output power of 360,000 kW of the Han Jiang and Bailong Jiang hydroelectric power stations. If we calculate the systematic investment of guaranteed output of each 4 Watts at 1,000-2,000 yuan, then 610-1,220 million yuan can be saved in investment; long range, it can improve the guaranteed output power of about 1,500,000 kW of the 13 or 14 cascades on the upper reaches of the Huang He and the cascades of Han Jiang and Bailong Jiang, saving an investment of 1.5-3.0 hunndred million yuan. If we take into account cross-over flow or compensation with the southwest (Sichuan) hydroelectric power stations, then the benefits are even more considerable.

In addition, since Longyangxia reduces the 100-year event major flood 1,050-4,500 m^3/s, it can improve the flood prevention standards of the Liujiaxia, Yanguoxia, and Bapanxia power stations and Lanzhou city, and can reduce the investment in diversion projects and sluice construction materials on the lower reaches by about 300 million yuan, and at the same time can improve diversion, ferry operations, reduced processing capabilities on the lower reaches, and cross-flow storage conditions of the power stations to be constructed on the lower reaches and shorten construction time, thus the multipurpose benefits are also extremely obvious.

II. View From the Perspective of the Even More Superior Development Conditions of Hydroelectric Power Stations Awaiting Construction, the Long-Liu Section Water Energy Resources Constitute a "Motherlode" Among "Motherlodes"

There are still 9 or 10 hydroelectric power stations awaiting construction on the upper reaches of the Huang He, with a rated capacity of 10,452,000 kW.

Because of the regulation of the two large reservoirs at Longyangxia and Liujiaxia, hydroelectric power stations which originally had only daily or weekly regulation capability became in effect multi-year regulation hydroelectric power stations and thus can both substantially increase the guaranteed output power of the hydroelectric power stations awaiting construction and also reduce flood waters a great deal, lowering construction coasts and shortening construction time. Thus, compared with the hydroelectric power stations already constructed, the farmland inundated per kilowatt of rated capacity is less than 10 percent of the stations already constructed, of which the Laxiwa, Lijiaxia, Gongboxia, and Jishixia power stations are only 1.7 percent; the number of people moved per 10,000 kilowatts is only 25 percent and 3 percent of the power stations already constructed and awaiting construction respectively; the volume of concrete work per kilowatt of rated capacity is only one-third that of the stations already constructed. From this it can be seen that if we refer to the upper reaches of the Huang He as a "motherlode" of hydroelectric power, then the economic indicators of the Laxiwa, Lijiaxia, Gongboxia and Jishixia hydroelectric power stations on the Long-Liu section are even better and it can be considered a "motherlode" among "motherlode". Compared with hydroelectric power stations nationally, the stations awaiting construction on the upper reaches of the Huang He have the following even more outstanding advantages:

1. The distribution of land and water resources on the upper reaches of the Huang He is unusually ideal, the water resources primarily come from above Lanzhou and the land resources are concentrated below Heishanxia, in particular there is the regulation of the three large reservoirs at Longyangxia, Liujiaxia, and Heishanxia (Xiaoguanyin or Daliushu) at the head, middle, and tail, not only permitting complete and rational use of the water resources, but also benefitting electricity generation greatly.

2. Due to the regulation of the large reservoirs at Longyangxia and Liujiaxia, the quality of electricity is the best in the nation. Guaranteed electricity makes up 82 percent of the multi-year average electricity, the quantity of electricity in level water years and low water years and the quantity of electricity in ordinary year flood periods and low water periods are basically the same.

3. Multipurpose use benefits are great. In addition to generating electricity, the irrigated area can be expanded over 10 million mu, and after construction is complete, a total of nearly 30 million mu of farmland can be irrigated. Also, the threat of floods and ice in Ningxia and Inner Mongolia can be alleviated and it will provide a flow of 250-300 m3/s on the middle reaches of the Huang He.

4. Losses due to inundation are small. Counties, cities and industrial and mining enterprises are not inundated, and only 73 mu of land is inundated per 10,000 kilowatts of rated capacity, or about 3 percent of the national average. The Laxiwa power station is typical, fully utilizing a 40-km long rapid current, steep-walled gorge to obtain a drop to 220 m. The rated capacity is 3,720,000 kW, and it only inundated a village of 150 persons. This is rare in China but in the northwest where there is much land and few people, the conditions for resettling nomads are very good.

5. The natural conditions are superior, the size of the project is small, flooding is minor, and there is little silt (making up only 1-14 percent of the silt on the lower reaches of the Huang He), topographical and geological conditions are very favorable for construction of a power station. The geological conditions of the power station dam sites are good; the seismic intensity is fairly low and the dam sites are mostly situated in the entrance or exit of a gorge, the overlying strata are shallow (generally 3-5 m), thus the volume of the project is small, with the concrete work only 1.4 m^3 per kilowatt of rated capacity, which is about 60 percent of the national average.

6. The economic indicators are superior. The investment per kilowatt of rated capacity is about 1,079 yuan, of which the investment per kilowatt of rated capacity is only 875.8 yuan for constructing the four power stations to be built on the Long-Liu section, and is 40 percent lower than the average norm for hydroelectricity nationally. The investment is about the same as for thermal power, but it does not require investment in coal and railroads, and the annual operating expenses are lower.

7. Experience has already been accumulated in constructing hydroelectric power stations on the upper reaches of the Huang He. In the surveying, design, scientific research, construction, manufacture and operation of the four large and medium-sized hydroelectric power stations constructed in the seventies, China relied on her own efforts and accumulated a wealth of experience, among which the Liujiaxia hydroelectric power station was the largest hydroelectric power station in the country at the time; the Longyangxia hydroelectirc power station which is about to go into production, has a dam height of 178 m and a single generator capacity of 320,000 kW. The construction of these five hydroelectric power stations has accumulated a wealth of experience and laid a very good foundation for the successive comprehensive development of the stations to be constructed.

8. The advance work has already been done in depth. The exploratory work for the hydrolectric power stations to be constructed has been basically completed, the preliminary design work for Lijiaxia and Daxia has been done, and feasibility study reports or preliminary designs for Laxiwa, Gongboxia, Jishixia, Xiaoguanyin, and Daliushu are planned for completion in 1986-1988.

9. The contradictions in construction are few. Except for the Heishanxia river section, which cuts across Gansu and Ningxia and for which the development scheme has not yet been decided, all the power stations to be constructed are primarily for generating electricity and there are no contradictions crossing between provinces and multipurpose departments, and the provinces (regions) actively support the accelerated development of the hydroelectric power stations on this section of the river.

Summarizing the above, the 9 or 10 hydroelectric power stations to be constructed on the upper reaches of the Huang He, whether compared with the stations already constructed on the upper reaches of the Huang He or compared with hydroelectric stations and thermal power plants nationwide, the technical and economic norms and development conditions are unusually superior and urgently require accelerated development.

III. The Important Significance of Accelerated Development of the Hydroelectricity on the Upper Reaches of the Huang He

The accelerated development of such superior water energy resources on the upper reaches of the Huang He has important significance for promoting the economy of the northwest, alleviating the situation of limited electricity in parts of China, welcoming the strategic shift in the development focus of China's economy, and spurring on the progress of the four modernizations.

1. Accelerated development of hydroelectric power on the upper reaches of the Huang He can spur on the rapid development of northwest industry and agriculture.

According to the predictions of the "Shaanxi-Gansu-Qinghai-Ningxia 30-Year Electric Power Generating Plan Outline (Draft)", to satisfy the needs of industrial and agricultural development and daily life, by the year 2000 the highest load in Shaanxi, Gansu, Qinghai, and Ningxia will reach 16,220,000 kW and rated capacity 20,966,000 kW, an increase of over 15,700,000 kW over the rating of the entire network. If in this time the more than 10,000,000 kW of hydroelectric power on the upper reaches of the Huang He can be fully developed, with the addition of the hydroelectric power stations under construction at Longyangxia and other places, it would take care of three-fourths of the increase rating required by Shaanxi, Gansu, Qinghai, and Ningxia, could supply 33,274,000,000 kWh of quantity of electricity generated each year, create a value of production of 2.16 billion yuan, which is equivalent to producing 18 million tons of raw coal per year. Qinghai, Gansu, and Ningxia have abundant metal ores, salt chemistry industry and coal resources, and using the high quality, low cost hydroelectric power of the upper reaches of the Huang He to develop high energy-consuming industries such as aluminum, nickel, copper, lead, zinc, and iron alloys and further develop such processing-intensive raw materials industries as the petrochemical industry, potash fertilizer and nonferrous metals can bring along the high speed development of northwest industries. At the same time, due to the continuous supply of high quality, low cost electric power and reliable water resources, the irrigated area of Qinghai, Gansu, Ningxia, and Inner Mongolia can be expanded by over 10 million mu on its existing base promoting greater expansion of agriculture in order to ensure more than self-sufficiency in grain. In addition, due to the regulation of the large reservoirs at the head, middle and tail, a stable flow of 250-300 m^3 can also be provided for the needs of agriculture on the middle and lower reaches of the Huang He and alleviate the flooding and ice disasters of Gansu, Ningxia, and Inner Mongolia, improve their ecological environment so that the northwest can rapidly escape poverty and become rich and reduce the gap between the northwest and the economically developed regions of China.

2. Accelerated development of hydroelectric power on the upper reaches of the Huang He and implementing an interconnected power grid of the Northwest with with North China, and the Southwest (Sichuan) can develop the good points and avoid the bad points and earn enormous benefits getting twice the result with half the effort.

The proportion of hydroelectric power in the northwest is big, but there is no way to fully exploit the many hydroelectric power peaks and advantages of reserve, so that when a dry year is encountered, system electricity becomes short and even limited. Yet starting and stopping thermal power is a slow process and it is difficult for conventional thermal power generators to satisfy the requirments of load valleys in the system. Implementing a Northwest-North China integrated power grid can fully exploit the advantages of the hydroelectric power and thermal power of two networks. Implementing a Northwest-Southwest (Sichuan) power grid also can earn enormous benefits. From this it can be seen that accelerated development of Huang He hydroelectric power, and expanding the power grid can develop the good points and avoid the bad points in a much larger electric power system and can earn enormous economic benefits by carrying out priority selection of power source and transmission projects.

3. Accelerated development of hydroelectric power on the upper reaches of the Huang He can improve the distribution of China's big energy-consuming industries and alleviate the situation of limited electricity in some areas.

China's energy sources and aluminum ore resources are abundant, but due to the shortage of electricity we have had to consume large quantities of foreign exchange for a long time to import aluminum.

Consumption of electricity accounts for 30-40 percent of the cost of aluminum, hydroelectric power costs are low, foreign aluminum power supplies take up over half of hydroelectric power but the proportion of coal-fired electricity for smelting aluminum is as high as 83.7 percent, and this is not sensible. Using the high quality, low cost hydroelectric power of the upper reaches of the Huang He for joint development or synchronous construction of aluminum and electricity can improve the power supply structure of China's aluminum industry, and ensure rapid development of China's aluminum industry; at the same time it can also change the impractical distribution of China's big electricity-consuming industries and alleviate the situation of limited electricity in areas where China's electric power and energy resources are in short supply and thus use the limited electricity to produce goods which a higher economic value. This would be unusually advantageous for accelerating national economic development.

IV. Measures for Accelerated Development of Hydroelectric Power on the Upper Reaches of the Huang He

As was stated above, the development conditions for hydroelectric power on the upper reaches of the Huang He are excellent, the economic benefits are unusually good and the significance is great, but why couldn't the actual pace of development in the past be very fast? Objectively speaking, it is due to the fact that these hydroelectric power stations are located in Qinghai, Gansu, and Ningxia, provinces (regions), 73 percent distributed in Qinghai, an area with a very poor economic foundation, there are limits to the load increase and in addition there was an insufficiency of construction funds, all of which limited its development speed. But actually, these objectively unfavorable conditions can be changed. We feel that a more

important element is first of all is that due to insufficient awareness in the past of the importantsignificance of developing hydroelectric power on the upper reaches of the Huang He no one treated this issue from the perspective of overall strategy, but only considered things as they stood, and in terms of investment, year after year gave in to the difficulties before them and lacked overall planning. This must be said to be a major error in policy making. Second is that due to inappropriateness of the construction system, overall planning considerations and arrangements were obstructed. In the past the Northwest Electricity Power Management Bureau only managed thermal power construction and power network dispatch operations. There was no agency to consider comprehensively how to carry out overall planning of hydroelectric power on the upper reaches of the Huang He. This not only was unfavorable for continuous development of cascades, but also was unfavorable for economizing on construction investment and shortening construction time. First, many current economic policies are not sensible, and are also unfavorable for the development of hydroelectric power. For example, after hydroelectric power construction investment was changed from appropriation to loans, the interest rate was too high, the repayment schedule was too short, and product taxes increased from 2 percent in the First Five-Year Plan to the current 25 percnet; electric rates have not changed for several decades so that the profit of the electric power industry is extremely small. Fourth, economic legislation is not sound and influences the initiative of departments and regions lacking electricity to invest in hydroelectric power on the upper reaches of the Huang He or carry out joint development with hydroelectric power.

On the basis of the above analysis, we think that to change the past situation of slow development we must first of all fully understand the necessity and important significance of accelerated development of hydrolectric power on the upper reaches of the Huang He, consider this matter from the angle of overall strategy and rapidly make policy decisions on overall planning. In terms of specific measures, they should be firmly rooted in reform, and seek solutions from reform, seek development from joint economies and encouraging competition, and start with reforming the hydrolectric power construction management system. For this reason, we propose the creating of the upper reaches of the Huang He joint hydroelectric power development company. This company can refer to the experience of the Lagrand River Development Company in Canada which implemented continuous cascade development and in 13 years constructed 3 cascade electric power stations on this river with a gross rated capacity of 10,269,200 kW and the experience of the U.S. Tennessee Valley Authority which was granted extensive rights to compenhensive development of the agricultural, forestry, and land resources in this area and beginning with vigorous development of hydrolectric power, rapidly developed the economy of this area so that income increased 44-fold in 47 years. After the Upper Reaches of the Huang He Joint Hydroelectric Power Development Company is established, in line with the principles of simultaneous cascade continuous development and flow process of the two sections of the river from Longyangxia to Sigouxia and from Liujiaxia to Qingtongxia, it should adopt methods of inviting tenders, submitting bids, and contracting and lower the investment per kilowatt on the current base 10-20 percent so that the large-scale hydroelectric power station main project's electricity generating

construction period is shortened to 3-5 years, and strive so that about the year 2000, that is to say in about 15 years time, the 9 or 10 cascade hydroelectric power stations will be basically built on this section of the river. The specific steps are:

1. The river section from Longyangxia to Sigouxia. Work will begin formally on the Lijiaxia hydrolectric power station in 1987, by 1994 two generators will be operating, and in 1996 the entire project will be completed; now the Lijiaxia hydroelectric power station critical construction is basically completed, in 1990 the critical construction of the Laxiwa hydroelectric power station will start, in 1997 two generators will generate electricity temporarily, and in the year 2000 it will be completed; after the critical project of the Laxiwa hydroelectric power station is basically completed, in 1993 work will begin on the Gongboxia hydroelectric power station, in 1999 two generators will be generating electricity and in 2001 the project will be completed; the two other hydroelectric power stations at Jishixia and Sigouxia will begin construction in 1995 and 1997, respectively, and by 2000 and 2001 they will be generating electricity, and by 2002 the five hydroelectric power stations on this section of the river will all be completed. The basic characteristic are cascade continuous development, flow processing, and for every three to four projects, one is carrying out "critical" construction, one is carrying out main body excavation and concrete pouring, and one project is installing generators and metal structures.

2. The section from Liujiaxia to Qingtongxia. In 1988 construction began on the Daxia hydroelectric power station, in 1993 it will generate electricity, and in 1994 construction will be completed; then the Heishanxia section will be developed and finally the medium-sized hydroelectric power stations will be constructed at Niaojinxia and Xiaoxia. Based on the principles of cascade continuous development and flow processing, by 2003 the give hydroelectric power stations on this section of the river will all be completed.

According to the plans for starting construction on the hydroelectric power stations and the technical and economic norms for the most recent different design sections for the hydroelectric power stations, the total investment in the 10 cascade hydroelectric power stations is about 11.76 billion yuan (not including investment in high tension lines). Funds granted by the state at the rate of 800 and 900 yuan per rated kilowatt and the net earnings (after deducting electricity used in the plant, generating costs, taxes paid, and interest) each year after the Longyangxia station begins generating electricity can be used as investment for power stations to be constructed and the company will contract for construction and raise any shortages in funds itself. State loan interest is taken at 2.4 percent and 3.6 percent per year, self-raised funds interest rate is 12 percent. After the stations begin generating electricity the electricity will be provided to the power network at 6 cents and 5 cents per kilowatt hour.

If the state contracts with the company in at 800 and 900 yuan per kilowatt of rated capacity at an annual interest rate of 2.4 percent and 3.6 percent, and sells electricity to the power network at 5 and 6 cents/kWh, calculating the maximum amount of state loans (including interest)

for constructing the ten cascade power stations at 5.92-8.38 billion yuan, the principal and interest of the self-raised loans will be 80-602 million yuan. Calculating the repayment period according to current stipulations (from the date of the loan until the principal and interest are completely repaid) is 18.1-22.9 years. In this period, the funds provided by Longyangxia will be 3.26-3.63 billion yuan, and the funds provided by the hydroelectric power stations which will subsequently go into production at Lijiaxia and Daxia will be 10.53-14.18 billion yuan.

We believe that the method for calculating the currently stipulated loan repayment period is not sensible because the loans provided by the state are paid out over many years and the repayment is also over many years thus the currently calculated loan repayment period and interest is bound to be too large. For this reason, we propose year-by-year calculation of the loan repayment period, i.e., the actual number of years starting with the date of the loan each year until the year that the principal and interest are completely repaid, treating the loan repayment schedule of that year, when necessary, by the weighted average method to calculate the average loan repayment schedule for each situation. This loan repayment schedule is 2.5-12.9 years, much shorter than the existing calculations.

If we do construct the Huang He cascade hydroelectric power stations according to the current method, we will not implement cascade continuous development and flow management and by the year 2000 we estimate we will only be able to build three to five hydroelectric power stations. The differences between the two paths and the two results are very great. From this it can be seen that the old method must not be adopted. The only path is to implement the above reformed method.

To implement the above plan we propose that the state implement the following unrestrictive policies:

1. Readjust the structure of China's fixed assets investment, increase the proportion of investment in electric power construction, give priority in electric power construction funds to developing hydroelectric power stations on the upper reaches of the Huang He which have excellent conditions and contract with the Upper Reaches of the Huang He Joint Hydrolectric Power Development Company at 800-900 yuan per kilowatt.

2. Except for interest and taxes which must be passedon to higher echelons by the Longyangxia hydrolectric power station which goes into production after the Seventh Five-Year Plan, the balance should be retained as upplementary funds for construction of hydrolectric power on the upper reaches of the Huang He until the hydroelectric power stations on this section of the river have been constructed and then repay the principal.

3. Implement multipurpose investment shares to reduce the construction funds for hydroelectric power.

4. Treat hydroelectric power as a one-time energy source and lower the hydroelectric power loan interest rate to that of the coal and petroleum interest rate, 2.4 percent.

5. Change the existing method of calculating loan repayment schedules to calculate the actual repayment schedule of loans each year.

6. We propose suitable increases in prices for electricity and the implementation of different electric rates for peaks and valleys, high-and low-water periods, among which the company approves the electric rate for providing power to the power network considered at 6 cents per kilowatt hour.

7. Develop horizontal economic connections, promote a northwest-southwest interconnected power grid and joint development of aluminum and electricity or early implementation of synchronous construction.

FOOTNOTES

1. The loan repayment periods in this paper were calculated by Liu Yuzhen [0491 3768 3791], Wang Yaoxun [8113], and Wang Xueming [3769 1331 2494].

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INTEGRATION OF NORTHWEST, NORTH, AND SOUTHWEST POWER GRIDS

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[Article by Wan Jingwen [8001 2529 2429], Northwest Exploration and Design Academy of the Ministry of Water Resources and Electric Power: "The Integration and Compensation of the Northwest China, North China, and Southwest (Sichuan) China Power Systems Can Provide More Benefits"]*

[Text] I. Introduction

To develop fully the peak regulation and reservoir compensation functions of hydroelectric power on the upper reaches of the Huang He, in 1983 the then Ministry of Water Conservancy and Electric Power made the topic of Northwest and North-Southwest China integrated power grid compensation a key ministry scientific research item and assigned joint responsibility for carrying it out to the Northwest and Chengdu Exploration and Design Academies and the Electric Power Scientific Research Academy (the Northwest-North China integrated power grid and hydroelectric and thermal power regulation were the responsibility of the Northwest Academy and the Electric Power Academy). With the vigorous support of relevant leaders and comrades of the Ministry of Water Conservancy and Electric Power and the former Water Conservancy and Hydroelectric Power Construction Bureau, through the joint effort of these three units, the Northwest-North China integrated power grid and the hydroelectric and thermal power regulatory work was completed in 1984 and passed ministry level appraisal; Northwest-Southwest (Sichuan) runoff electric power compensation and interconnected power grid research work is still going on and it planned for completion at the end of 1986. This paper is based on the comprehensive research results described above.

The following important results have already been obtained from the above research : (1) The functions of the Northwest-North China integrated power grid project have been expanded from the past functions of "generating electricity in the west and transmitting it to the east", playing a role in peak regulation of Northwest hydroelectric power to three major functions of peaks, valleys, and increasing the guaranteed quantity of electricity of the Northwest, and proposed expanding the transmission capability of the integrated power grid project, especially increasing the reverse transmission capability by 640,000 to 1 million kW which alone can save 210-330 million yuan. And increasing the Northwest's guaranteed quantity of electricity

3,562,000,000 kWh; at the same time it was also proposed that the starting point of the interconnected power grid be shifted west from Gaolan, Gansu to Pinganyi, Qinghai, which can save 169 million yuan in investment. (2) On preliminary calculations Northwest-Southwest interconnected power grid compensation can increase the useable quantity of electricity by more than 5 million kWh, and guaranteed output more than 1 million kW, reduce the thermal power rated capacity more than 1.5 million kW. To build thermal power in the Southwest which could obtain similar benefits would require an investment of 2.4 billion yuan, but the investment in the Northwest-Southwest interconnected power grid is only 1.1 billion yuan, a reduction of 1.3 billion yuan.

II. Research on Northwest-North China Integrated Power Grid and Thermal Power Compensation

The feasibility study of the Northwest-North China integrated power grid was undertaken at the decision of relevant upper echelons by the Northwest-North China Electric Power Design Academy which presented its report at the end of 1984.[1] Our focus was to study how the thermal power plants of these two power grids could carry out compensation regulation in order to give full play to the advantages of each. The primary research results were affirmed in the appraisal opinion of this topic by the Ministry of Water Conservancy and Electric Power's Office of Science and Technology and the former Water Conservancy and Electric Power Construction Bureau and the documents of approval handed down by the Ministry of Water Conservancy and Electric Power after examining the Northwest-North China Interconnected Power Grid Feasibility Study Report and are detailed below:

1. Role of the integrated power grid project

Northwest hydroelectric power and North China thermal power both have their advantages and disadvantages: the advantage of hydroelectric power is that it is easy to start and stop, operation is flexible, and investment to expand rated capacity is small, it is most suited for the tasks of regulating peaks, regulating frequency and accident reserve in a power grid; however, when especially dry years are encountered and the volume of water is insufficient, the volume of electricity diminishes and there is a shortage or even restriction on electricity in the power grid. But in North China the coal reserves are abundant and the proportion of thermal power is 93 percent. The advantage of thermal power is that as long as the supply of coal can be guaranteed, it can operate stably at basic load, thus its generating volume is large; the shortcoming is that starting and stopping are slow and not suited to undertaking the task of excessive peak regulation of power grids. If there is a high peak load in the Northwest-North China integrated power grid, Northwest hydroelectric power can be transmitted to North China to regulate the peak; in low load periods, the excess hydroelectric power is transmitted to the Northwest to fill in the valleys. When there is a shortage of electricity in the Northwest due to an especially dry year or for other reasons except for transmitting electricity from the Northwest to North China 4 hours a day for peak regulation, the other 20 hours as much North

China thermal power is transmitted to the Northwest as possible in order to improve the operating conditions of North China thermal power and through regulation of the Northwest's reservoirs converts it into Northwest guaranteed electricity. In this way, the Northwest-North China integrated power grid project, in addition to having the benefits of so-called "generating electricity in the west and transmitting it to the east", helping the North China power grid to regulate peaks, obtain large power grid staggered peaks, reduce reserve and make more use of a portion of seasonal Northwest hydroelectric power, what is even more important is that it can enjoy three major functions of helping North China regulate peaks, fill valleys, and increase the Northwest guaranteed quantity of electricity. 2, 3

2. Research on increasing transmission capacity, especially increasing reverse transmission capacity

To improve the economic benefits of the Northwest-North China integrated power grid and the hydroelectric and thermal power of the two grids it is necessary to enlarge the forward and reverse transmission capacity of the integration project. On the basis of calculations of the transmission distance, voltage level and line cross-section of the integrated power grid, the maximum economic transmission capacity is above 1,600,000 kW, so to leave some leeway, the forward transmission capacity is provisionally fixed at 1,600,000 kW.

Concerning the scale of reverse transmission capacity, we studied in detail such issues as the benefits to be obtained and the investment necessary to increase reverse transmission capacity and safe operation. Because the investment to increase different reverse transmission capacities is very small, only 3-15 yuan per kilowatt, but the valley-filling benefits are very big, a saving of 333.3 yuan per kilowatt, or 22-111-fold the investment. In addition, the benefits of increasing Northwest guaranteed quantity of electricity are not included in these calculations. For this reason, considered in terms of economics, it is rational to increase the reverse transmission capacity. As concerns the matter of the operational safety of increasing reverse transmission capacity, we also conducted detailed analytical calculations and the conclusion is: safety is guaranteed as long as suitable measures are adopted. Thus, we propose that the reverse transmission capacity of the Northwest-North China integrated power grid should be constructed at 90-100 percent of the forward transmission capacity, initially operating the reverse capacity at 1,000,000 kW, then subsequently gradually increasing the reverse capacity with increases in the Northwest power grid load and accumulation of operating experience.

3. Research on mode of operation of the Northwest-North China integrated power grid project

The mode of operation is the key to reflecting the economic benefits and role of the Northwest-North China integrated power grid and we research in detail mode of operation of the Northwest-North China integrated power grid under different circumstances:

1) Mode of operation when Northwest grid power and quantity of electricity are plentiful.

When in level water years and abundant water years Northwest hydroelectric power output is large but water is not discarded, if there is no shortage of electricity in the North China power grid, to reduce the working capacity of North China thermal power and the gaps between peaks and valleys, the mode of operation is: when North China is at peak load, Northwest hydroelectric power sends 1,600,000 kW to regulate North China peaks; when North China is at low load, North China reverse transmits 800,000-1,000,000 kW to the Northwest. The rest of the time, to reduce line losses, the Northwest-North China integrated power grid only plays a role in interconnections and accident reserve and generally should not be transmitting electricity; if North China thermal power capacity is insufficient or coal supplies are short, except for North China reverse transmitting a certain amount of electricity to the Northwest to satisfy the demands of gaps between peaks and lows in the Northwest, the rest of the time the Northwest transmit electricity to North China, and year-round the Northwest power grid can transmit approximately 4 billion kWh of electricity to support North China.

2) Mode of operation when Northwest hydroelectric power is discarding water

Since the Northwest reservoirs are large and multi-year regulatory, even if there is a year with abundant water only in August and September it is possible that water will be discarded and the positive values of the North China load and the gap between peaks and valleys in these months is the shortest time of the year, and if at this time arrangements are not made for inspection and repair of North China hydroelectric power and energy storage water drawing machinery and a peak accident reserve capacity is not set up (if an accident occurs in a peak generator at this time, then the method of thermal power being reverse-transmitted from North China to the Northwest during valley periods is adopted to ameliorate the peak and valley gap in North China), thus the ability of the North China power grid equipment to handle gaps between peak and valley is also greater than in other months. At this time, when the Northwest is discarding water, under normal circumstances, when it is a low valley load, North China thermal power does not provide electric power or electricity for the Northwest.

To reduce the water discarded by Northwest hydroelectric power and to generate more electricity and transmit more electricity to the North China power grid, the electricity transmitted by the Northwest on the North China daily load curve should be placed above the minimum output power of North China thermal power (including the water-drawing load of North China power stations drawing water for energy storage) so that Northwest hydroelectric power plays its proper role in helping North China regulate peaks, but as much as possible also causes Northwest hydroelectric power to generate more electricity, and provide more seasonal electricity to the North China power grid. At this time, the Northwest could transmit approximately 800,000,000 kWh to North China every month.

3. Mode of operation in dry years when there is a shortage of power in the Northwest

In especially dry years when the quantity of hydroelectric power generated by the Northwest is small, there is a shortage of power in the grid even to the point where it must be rationed; or due to such factors as the Northwest load having grown too fact, power supply construction has not yet caught up and accidents with generators occur leading to a shortage of power. At such times, in addition to the 4 hours of highest daily load of the maximum load when power is in rather short supply, there is an abundance of electric power, thus the mode of operation of the Northwest-North China integrated grid in dry years is when the Northwest power grid is at peak load, the Northwest transmits 1,600,000 kW of power to regulate the Northwest peak. At other times, when the Northwest-North China integrated grid reverse-transmission capability and safety permit, North China thermal power will generate as much as possible and reverse transmit the surplus to the Northwest, the non-uniformity of the quantity of electricity reverse-transmitted from Northwest hydroelectric power for North China compensatory regulation and the daily, monthly, and annual power use load changes it to Northwest guaranteed quantity of electricity.

The size of the increase in Northwest guaranteed electric quantity is primarily related to such factors as the amount of forward and reverse transmission capacity, the size of the Northwest thermal power peak regulation capability, and the load characteristics of the North China power grid. When the North China load curse is fixed, the forward transmission capacity is 1,600,000 kW and the reverse transmission capacity is 800,000-1,440,000 kW. When the maximum North China thermal power peak regulation capacity does not exceed 20 percent, the net North China guaranteed quantity of electricity reverse-transmitted to the Northwest, is between 597,000,000 and 9,427,000,000 kWh. The mode of operation of the normally smaller quantity of electricity reverse transmitted is: in the 12 months of the year, the Northwest capacity transmitted to North China for peak regulation on the maximum North China load day of each month is 1,600,000 kW, and the working capacity of the maximum load day of North China hydroelectric power is determined on this basis. At valley load times, the maximum reverse transmission capacity of North China thermal power is 1,000,000 kW, and the capacity of the gap between peak and valley regulation of North China thermal power and the percentage of the working capacity is determined from this. On other low-load days, the percentage of gap between peak and valley regulation which is accepted by North China thermal power according to the maximum load day of that month conversely determines the working capacity of thermal power and the capacity of corresponding Northwest hydroelectric power which should be forward transmitted. Finally, the quantity of electricity which the Northwest forward transmits to North China, the quantity of electricity which North China reverse transmits to Northwest, and the net quantity of electricity which North China reverse transmits to Northwest is calculated for each month and the entire year. According to the calculations of reference 2, the net quantity of electricity which North China reverse transmits to Northwest for the entire year is 3,562,000,000 kWh.

4. Starting point of integrated power grid

Considering that the investment in lines for direct current integrated power grid is less, shifting the starting point to the west can bring it closer to the primary transmitting hydroelectric power station at Lijiaxia and can simplify the output lines of this power station to one voltage of 330 kV. Thus, we propose shifting the starting point of this power grid from Gaolan in Gansu to Pinganyi in Qinghai, which can reduce investment 169 million yuan.

5. Calculating investment benefits of the integrated power griad

Settling the starting point of the Northwest-North China integrated power grid at Pinganyi in Qinghai and the end point in Beijing Municipality, using a $\pm$500 kV direct current integrated power grid with a length of about 1,600 km, a transmission and transforming project investment of 1.13 billion yuan, with the additional investment of 260 million yuan in expanded rated capacity of 800,000 kW at Lijiaxia, the total comes to 1.39 billion yuan.

The benefits of the project are primarily: it replaces 1,600,000 kW working capacity of North China hydroelectric power (the Ministry of Water Conservancy and Hydroelectric Power finally approved a forward transmission capacity of 1,800,000 kW, and after taking line losses into account, about 1,600,000 kW will be transmitted to North China), staggered peaks and reduced reserve capacity of 880,000 kW, the total of the two is 2,480,000 kW. Calculating at 930 yuan per kilowatt, 2.31 billion yuan in investment can be saved and the gap-filling benefits of 1,000,000-1,600,000 kW can save 330-530 million yuan in investment for a total saved investment of 2.64-2.84 billion yuan, about three times the investment of 1.39 billion yuan required for integrated power grid. In addition, the benefits of such elements as increasing the guaranteed capacity of the Northwest and the guaranteed output and the quantity of electricity generated annually of Northwest hydroelectric power which can be raised and lowering the coal consumption of North China peak regulation thermal power are not included in the calculations. From this it can be seen that the Northwest-North China integrated power grid is very economical, and it is an important project which can take care of the gap between peaks and valleys in the North China power grid, improve thermal power operation, and increase Northwest hydroelectric power benefits.

III. Research on Northwest-Southwest (Sichuan) Cross-valley Compensation

Sichuan's water energy resources are abundant and can be developed to 90,000,000 kW, making up 26.8 percent of the developable water energy resources nationwide. However, since the flow is rather large, and adding on the limitations of such conditions as topography, geology, and flooding, the capacity of hydroelectric power station reservoirs which have been constructed or are planned for construction in the near term, the regulatory performance is poor. Thus, the variation in hydroelectric output is very large, with the ratio of high-water periods to dry years of 2.1:1. The yearly output of a level water year is about 10-15 percent greater than a dry year, so that in

dry years, idle hydroelectric capacity is considerable, power grid electricity is insufficient, and there is no way to utilize fully the large seasonal power of high-water years.[4]

Northwest coal and water energy resources are both more abundant, and in the Longyangxia to Qingtongxia section of the Huang He especially, the quantity of water is stable, inundation losses are small, investment is small, and development conditions are excellent. The Longyangxia, Liujiaxia, and Heishanxia (whether first level or second level development mode has not yet been determined) large reservoirs at the head, middle, and tail sections have a total capacity of up to 37.2 billion m^3, and can realize multiyear regulation. The long-range energy storage for the three large reservoirs is 48 billion kWh, basically the same as the total quantity of electricity generated by the cascade power stations on this section of the river, of which the Longyangxia reservoir's total capacity is 24.7 billion m^3, the control head is about 1,000 m, and the reservoir energy storage is 43 billion kWh. Since the reservoir regulation time interval can be as long as 11 years, these reservoirs can only be used in the Northwest power grid and their benefits cannot be fully exploited; in addition, the 1,800,000 kW capacity transmitted by the Northwest to North China in the Northwest-North China integrated grid only operates for about 4 hours at peak load times, so the utilization rate is low. Under these circumstances, if in the Northwest-Southwest (Sichuan) integrated power grid Sichuan generates a great deal of hydroelectric power in high water periods, including hydroelectric power generated for the overall accident reserve and load reserve capacity undertaken by hydroelectric power, the excess Sichuan load could be transmitted to the Northwest grid or even the North China grid and at such times, while satisfying the multipurpose demands of irrigation and flood prevention, Northwest hydroelectric power could generate less power and store more water and more energy. In dry periods it would be the reverse, the hydroelectric power station reservoirs on the upper reaches of the Huang He would release more water for generating power and the portion in excess of NOrthwest power grid demands could be transmitted back to the Southwest power grid. In essence, this is using the reservoirs on the upper reaches of the Huang He to help Sichuan hydroelectric power stations carry out runoff regulation in order to alleviate the problem of the unevenness of Sichuan hydroelectric power's high and dry output and thus could greatly increase the useable capacity and guaranteed output of hydroelectric power stations so that those stations whose economic benefits are not high could become very economic.

The extent of the Northwest-Southwest hydroelectric power benefits has a very big relationship to the load characteristics of the two power grids, the hydroelectric power rated capacity, the unnevenness of Sichuan hydroelectric power output, and the forward and reverse transmission ability of the Northwest-Southwest integrated power grid and its mode of operation. On the basis of the most recent materials on the load of the two power grids in the year 2000 and the designed rated capacity of hydroelectric and thermal power, if the forward and reverse transmission capacity of the Northwest-Southwest interconnected power grid is 1,800,000 kW, the useable capacity which can

be increased is 4,860,000,000 kWh, and guaranteed output is 1,040,000 kW. With the passage of time and the steady increase in hydroelectric power stations in Sichuan and on the upper reaches of the Huang He, its compensasation and integrated power grid benefits are bound to become greater. According to preliminary estimates, by 2015 the useable quantity of electricity that can be increased on this circuit is close to 6.7 billion kWh, and guaranteed output is 1,360,000.

To implement compensatory regulation of Northwest-Southwest hydroelectric power it is necessary to construct the Northwest-Southwest integrated power grid. Taking into consideration that the voltage above 330 kV in the Northwest power grid cannot be settled for a short time but that there is no stability problem in the direct current integrated power grid, the two power grids can operate independently. They are both very simple in terms of technology and administration and management and to leave some leeway, temporarily taking the direct current power grid which requires more investment as a representative, with the starting point in Chengdu, Sichuan, and its end point at Tangsaitan near the Lijiaxia hydroelectric power station in Qinghai, via Chengdu, Deyang, and Qingchuan in Sichuan, Kang Xian, Wushan, and Linxia in Gansu, and Xunhua and Jianzha in Qinghai--a total length of about 940 km--for a gross investment of about 1.1 billion yuan (converted at current $U.S.),

After constructing the Northwest-Southwest integrated power grid, while not increasing the rated capacity of the Northwest and Southwest and comprehensively satisfying the multipurpose demands of the hydroelectric power stations, we need only improve as appropriate the mode of operation of the hydroelectric power stations and expand the annual regulatory capacity of the Longyangxian reservoir by about 3 billion m^3 to improve greatly the generating benefits of the hydroelectric power stations. As we said above, the increase in guaranteed output is 1,040,000-1,360,000 kW, useable quantity of electricity is 4.86 billion to 6.7 billion kWh, and to leave some leeway, in this paper we calculate it according to an increased guaranteed output of 1,000,000 kW and a useable quantity of electricity of 5 billion kWh. In addition, by the year 2000 the peak and reduced reserve capacity of the integrated power grid will be about 1,000,000 kW--in this paper we consider it as 500,000 kW--so the total reducible thermal power rating is 1,500,000 kW, an annual saving of about 2.75 million tons of coal. This reduces the investment in thermal power by 1.3 billion yuan and investment in coal mines and railroads by about 1.1 billion yuan, for a total savings in system investment of 2.4 billion yuan, or three times the investment in the NOrthwest-Southwest integrated power grid. Even if we do not calculate the benefits of expanding the integrated grid, the investment of 1.1 billion yuan will provide us with 1,000,000 kW in guaranteed output power and a useable quantity of electricity of 5 billion kWh. This represents an average annual investment per kilowatt of guaranteed output of only 1.100 [sic] yuan, an investment of .22 yuan per kilowatt-hour, or only 40 percent of the 2,704 yuan per kilowatt of guaranteed output, and 83 percent of the 0.266 yuan per kilowatt-hour of the Lijiaxia hydroelectric power station on the upper reaches of the Huang He

where the economic indicators are excellent. Since there will be an annual 5 billion kWh of electricity, the operating expenses will be low. Therefore, the Northwest-Southwest integrated power grid is much more economical than building thermal power or hydroelectric power, especially in that the water energy resources of Sichuan are extremely abundant. But their lack of regulatory reservoirs seriously affects the economic benefits of hydropower stations with the result that water energy resources are not more developed. After compensatory regulation of the Northwest-Southwest integrated power grid, the useable electricity and mandatory capacity of Sichuan's hydroelectric power can be greatly expanded, thus the compensation of the Northwest-Southwest integrated power grid has strategic importance for improving economic benefits of Northwest and Southwest hydroelectric power and for accelerating the development and utilization of the hydroelectric power in these two areas.

IV. The Economic Benefits of Constructing Northwest-Southwest Integrated Power Grid After the Northwest-North China Integrated Power Grid Are Even Clearer

Since the peak regulation capability of the North China power grid is seriously inadequate, after repeated expounding and proving by relevant areas, the Northwest-North China integrated power grid project is a most economical proposal to alleviate the problem of peak regulation in the North China power grid, and thus relevant departments demand that it be constructed as quickly as possible. Under these conditions, some comrades have said that under peak loads in North China, the Northwest hydroelectric power's rated capacity is already fully utilized, and they are powerless to interconnect with the Southwest, for runoff electric power compensatory regulation. In the view of these comrades, if we have a Northwest-North China integrated power grid, then it isn't suitable to go on to construct a Northwest-Southwest integrated power grid. But we feel that the roles of the Northwest-North China and Northwest-Southwest integrated power grids are completely different. From the perspective of compensatory regulation, the former compensates within the day, while the latter compensates within the year. Although the Northwest has no power to transmit to the Southwest during North China's 4 peak hours in the dry season, for the other 20 hours of the day, the Northwest's peak can be fully used to transmit North China's 1.8 million kW capacity to the Southwest every day. As for the lack of electric power when the Southwest is at peak load, generally this can be handled by using the redundant capacity of the hydroelectric power stations and the surplus reserve capacity of the expanded integrated power grid, and if this should be inadequate then it would be rational to expand the capacity of Sichuan's hydroelectric power stations. Thus, the two integrated power grids are not in opposition, but can exploit the advantages of the three large power grids even more and even faster: during dry periods North China thermal power can generate more electricity at low-load times to help out the Southwest; at flood periods it will generate less electricity and accept more seasonal electricity from the Southwest and thus increase the benefits of filling in the gaps of North China, Southwest guaranteed output and useable electricity, and thus the economic benefits of first constructing the Northwest-North China integrated power grid and then the Northwest-Southwest integrated power grid will be clearer.

V. Conclusion

1. The investment required to construct the Northwest-North China and Northwest-Southwest integrated power grids is only about one-half the investment for the power grids to construct related projects separately so the investment they reduced is more than 1.2 billion yuan, the annual operating expenses are also greatly reduced, and the economic benefits are enormous, thus, we propose accelerating the exploration and design work for these two integrated power grids, quickly getting started on feasibility studies on the Northwest-Southwest (Sichuan) integrated power grid and strive for an early start to construction.

2. Because the benefits of integrated power grids of different power sources are large, we propose that while relevant hydroelectric power design units are carrying out river flow planning and participating in electric power system planning, they should pay attention to researching the issue of integrated grids which cross large areas, selection of power sources and grid structure and the problem of improving hydroelectric power station parameters from the perspective of the overall view and the large system view and avoid solving problems independently from the aspect of a small power grid.

3. In power grids with a large proportion of hydroelectric power, hydroelectric planners and designers must study problems of power supply compensation and corresponding power grid planning. This is because hydroelectric power planners and designers are well versed in the characteristics of hydroelectric power, and developing various power supply compensatory regulation is their long suit, but hydroelectric power design academies currently also lack electric power system professionals, thus, we propose making hydroelectric power design primary and cooperating with relevant electric power design academies and electric power design scientific research academies to carry out research on power source compensation together.

FOOTNOTES

* Personnel participating in these two projects were: Comrade Wan Jingwen, Yu Zifang [0151 3320 5364], Wang Huazhong [3769 0553 0022], He Chengyi [0149 2110 5030], Wang Yaoxun [3769 3852 0534], Liu Yuzhen [0491 3768 3791], Xu Zhengxiong [1776 1767 7160], Yao Guoshan [1202 0948 3503], Li Hang [2621 5300], Liu Daoxiang [0491 6670 4382], Yu Fengyi [0060 7364 5030], Li Yunhong [2621 0061 5725], Zhou Xiaoyang [0719 1420 7122], Yang Haitao [2799 3189 3470], Dai Weiyong [2071 4850 0516], Zhou Dechang [0719 1795 1603], and Tang Rongbin [0781 2837 2430]. Comrades Cao Xuemin [2580 1331 2404] and Zhang Yugang [1728 3022 0474] participated in relevant meetings of the two projects, and provided helpful guidance; Comrades Ding Gongyang [0002 0501 2254] and Zhu Yunsheng [2612 0061 3932] provided valuable opinions on the Northwest-North China integrated power grid and research on hydroelectric and thermal power compensation, for which we thank them here.

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CSO: 4013/41

YUNNAN'S MANWAN COULD GENERATE POWER BY NOVEMBER '87

OW130623 Beijing XINHUA in English 0606 GMT 13 May 87

[Text] Chengdu, 13 May (XINHUA)--The [Manwan]power station on the Lancang River in Yunnan Province will start generating [power] this November, 1 year ahead of schedule.

The station, with a projected capacity of 1.5 million kilowatts, is the largest in southwest China.

"Preparations started in October 1985, and building the main structure took only 7 months," an official from the Ministry of Water Resources and Electric Power said, adding [that] construction of another five big power stations is also being accelerated.

According to the official, "this rapid rate of construction is rare in China, and the speed is due to new investment and construction techniques."

"Now the central government and the province jointly invest in construction, instead of the investment coming solely from the central government," the official explained, "and construction bids are invited, instead of construction contracts being fixed only by the Hydraulic Engineering Bureau."

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CSO: 4010/54

GUIZHOU TO SPEED DEVELOPMENT OF HYDROPOWER ON WU JIANG

HK300734 Beijing CHINA DAILY in English 30 May 87 p 1

[Article by staff reporter Xu Yuanchao]

[Text] Guizhou, one of the poorest provinces in China, expects to speed up developing of its hydropower resources on the Wujiang to boost the economy.

Twenty-four experts voiced their views on how to accelerate the development of the hydropower stations on the river at a 2-day seminar in Beijing.

Guizhou Governor Wang Chaowen suggested that a Wu Jiang hydropower development corporation should be set up to build and manage the river's nine hydropower stations, which have a planned combined capacity of 8,560 megawatts and a planned annual power output of 42 billion kilowatt-hours.

The Wu Jiang, 1,037 kilometers long, is one of the largest tributaries on the upper reaches of the Yangtze River and the most important river in Southwest China, draining an area of 87,920 square kilometers.

At present, the 630-megawatt Wujiangdu hydropowre station has been completed and produces 3.3 billion kilowatt-hours a year.

Another, the Dongfeng hydropower station, has a 168-meter-high dam and a capacity of 510 megawatts. It is expected to be completed by 1991, said Zhao Yukuan, division chief of the Institute for Design of Hydropower Stations.

Zhao said feasibility studies are being made for another four stations and the remaining three stations are being considered by local authorities.

He told CHINA DAILY yesterday that 46 experts toured the river last month.

Experts concluded that the Wu Jiang is one of the three rivers in China with rich hydropower resources, the other two being the Hongshui He and upper reaches of the Yellow River.

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CSO: 4010/54

OPEN BIDDING ON LUBUGE CUTS COST, SPEEDS CONSTRUCTION

OW281220 Beijing XINHUA in English 1109 GMT 28 Jun 87

[Text] Beijing, 29 Jun (XINHUA)--The success with open bidding for construction of the Lubuge power station has gained China useful experience in the field.

The project, the first to be built with World Bank loans in China with a total generating capacity of 600,000 kW, involves an investment equal to 980 million yuan. Its first unit will be operational in the first quarter of 1989.

The country offered the project for open bidding in 1983 and a Japanese contractor won the contract for building the water diversion tunnel. The tunnel is expected to be completed 3 months ahead of schedule, an official from the Ministry of Water Resources and Electric Power said.

"The bidding has cut costs, speeded up the construction and introduced advanced design and building technology," the official said.

"The Ministry of Water Resources and Electric Power is promoting the practice and is inviting tenders for other large hydraulic projects, including the Shitang power project in Zhejiang, Yantan on the Hongshui He, Manwan in Yunnan, Shuikou in Fujian Province and Lijia gorge on the upper reaches of the [Huang He].

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CSO: 4010/56

BRIEFS

SMALL SICHUAN STATIONS FLOURISH--Local electric power undertakings, with the focus on hydroelectricity, are flourishing in Sichuan. The province now has 6,541 small hydroelectric and thermal power stations, with a total installed capacity of 1.2 million kilowatts, representing more than one-fourth of the province's total installed capacity. Local power stations last year generated 4.56 billion kilowatt-hours, one-fifth of the provincial total. Some 94 percent of townships and 76 percent of villages in the province now have power supply. [Summary] [Chengdu Sichuan Provincial Service in Mandarin 0000 GMT 15 Jun 87] /8309

JINSHUITAN'S NO. 1 GENERATOR OPERATIONAL--After 6 years of intense construction, Zhejiang's second largest MMM hydropower station--the Jinshuitan station located in Yunhe--officially put its No. 1 generator into production on 3 April following a 72-hour trial run; a powerful and steady flow of electricity is now being fed into the East China Grid. The station's No. 2 generator has also been put into the trial operation stage. The Jinshuitan hydroelectric power station belongs to those major state projects of the Sixth Five-Year Plan. It has six generators for a total installed capacity of 300,000 kilowatts and will generate some 500 million kilowatt-hours of electricity a year. Its dam stands 102 meters tall. Its operational status lifts the curtain on the cascade developments of the Ou Jiang, not only furnishing electricity but also enhancing irrigation and navigation for the southern mountainous region of Zhejiang Province. In addition, it will boost the capability of the East Chian Grid to regulate power during times of peak usage. [Excerpts] [Hangzhou ZHEJIANG RIBAO in Chinese 4 Apr 87, p 1] /12223

CSO: 4013/80

CEI PREDICTS CONTINUED STABLE COAL PRODUCTION

OW010732 Beijing XINHUA in English 0539 GMT 1 Jun 87

[Excerpts] Beijing (CEI)--This year, China's coal production will remain stable, but show a slight drop, according to a recent meeting of the China Coal Economic Information System.

Overall, in 1986, adequate coal supplies created a buyer's market, even though supply fell slightly short of demand in east, central, and south China because of transportation problems.

In 1987, China plans to mine 885 million tons, a drop of 9.04 million tons, or 1 percent less than 1986.

Coal producers in Liaoning, Jilin, and Heilongjiang provinces are to cut production by 13 million tons, and six other areas--Inner Mongolia, Henan, Hunan, Guangdong, Guizhou, and Shaanxi--have been asked to reduce output.

"In terms of demand, industry will need 501 million tons in 1987, an increase of 20 million tons over last year," according to statistics from the [ministry of] Metallurgy industry, the Ministry of Railways, the Ministry of Water Resources and Electric Power and the chemical industry ministry. Retail sales will go up by 20 million tons to 202 million tons.

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CSO: 4010/50

EXPANSION OF SHENFU FIELD NOW 'IN FULL SWING'

HK070846 Beijing CHINA DAILY in English 7 Jul 87 p 2

[Text] Expansion of China's largest coal mine, Shenfu, is in full swing, CHINA DAILY learned last week.

According to the Ministry of Coal Industry, the 13.000-square-kilometre coal field in the basin area linking Northwest China's Shaanxi Province and the Inner Mongolia Autonomous Region has produced more than 2 million tons of coal since last year.

This year, another 15 paris of pits will be put into operation. By 1992, the coal field is expected to produce 10 million tons of coal, and by 1995 the figure will triple.

When fully operational in the year 2000, the coal field will be able to produce at least 60 million tons a year, thus becoming the country's most important coal production and export center, the ministry said.

The coal field has verified reserves of more than 200 billion tons, nearly one-third of the country's total. China produced 890 million tons of coal last year, and exported about 9.9 million tons.

The current first-phase construction of the coal field includes an 87-kilometre road network, a 110,000-volt power transmission line, and two railways.

Construction of the 100-kilometre railway running from Baotou in Inner Mongolia to Shenmu in Shaanxi Province started in June last year. When completed next year, it should be able to carry 10 million tons of coal a year.

Work on the second railway is to begin soon. Linking Shenmu to Suoxian County in Shanxi Province, the railway is designed to carry 30 million tons of coal a year.

Work also has begun on building a road linking Baotou, Shenmu and Fugu in Shaanxi Province. In addition, a thermal power [plant] is under construction, and preparations are underway for a long-distance telephone trunk line from Xi'an, capital of Shaanxi Province, to Shenmu via Yuling.

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CSO: 4010/60

USING COAL AS OIL SUBSTITUTE REAPS BIG DIVIDENDS

Beijing RENMIN RIBAO in Chinese 12 Jan 87 p 1

[Article by staff reports Chen Jian [7115 0256] and Liu Yunzhou [0491 0336 3166]: "Using Coal Reduces Burning of Oil and Produces Marked Results--More Than 10 Billion Yuan Saved in 6 Years Throughout the Country"]

[Excerpts] By the end of 1986, marked results had been obtained in the more than 6 years of work by China to substitute coal for oil and reduce the burning of oil. In 6 years, it is calculated that there was a reduction of 24.8 million tons of oil, amounting to 12.2 billion yuan and nearly U.S. $3 billion in foreign exchange was generated. A large portion of the accumulated funds was used on energy, transportation, and their accompanying engineering and construction where the focus is on operating electric power plants. In 6 years, 2.6 million kW of power generating equipment have gone into production. In evaluating the results of the work on reducing oil consumption, leading comrades of the State Council have said: "This money is heaven-sent. If we had not changed to coal, everyone would still be using oil, and there would be none of this money to develop energy and transportation."

China's oil-burning facilities began to increase greatly from the 1970s. Under very tight coal, electricity, oil, and transportation conditions, large amounts of oil-burning seriously restricted the development of the national economy. In 1980 alone, about 40 percent of the petroleum output throughout China was burned as fuel, of which half was used to fire boilers. Not only is this a serious waste of resources, it also creates a large economic loss. At 1981 international oil prices, and compared with burning coal, it is equivalent to burning U.S. $5 billion.

At the suggestion of Comrade Zhao Ziyang, in the spring of 1981 the State Council made an important decision, one to substitute coal for oil, reduce oil exports, accumulate funds, and, on the other hand, to develop weak energy and transportation [areas]. Moreover, the task to reduce the burning of oil by 20 million tons for 10 years was determined, and it was decided to establish specialized organs to handle this work. The practical experience of more than 6 years has shown that this has definitely boosted the nation's economy. These decisions have speeded up the construction of electrical power in China and have been effective measures in the construction of coal mines and railroad transportation with complete power sets.

The leading comrades at the State Council's Office of Substituting Coal for Oil, said that there are three outstanding advantages to implementing these measures: the first is enabling energy to be used rationally and to enable power plants, industrial boilers, and other irrational oil-burners to be able to reverse [this trend]; the second is to raise the utilization value of petroleum and to reduce oil output with a portion being used to increase the foreign exchange generated from exports and a portion being used for further processing; the third is to open up a major bridge to accumulate energy and transportation construction funds. Eighty-five percent of the accumulated funds from oil reduction is used for the engineering and construction of energy and transportation projects. The 7th FYP will use this money to build and put into production 12 million kW of power generation equipment, making up about one-third of the new increases throughout the country.

Leaders in the State Council have indicated that the work of substituting coal for oil and the related policies will be extended to the end of this century and that, in the last 10 years [of the century], oil-burning will be reduced another 10 million tons.

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CSO: 4013/40

SUCCESS NOTED IN GASIFICATION OF UNDERGROUND COAL

OW060834 Beijing XINHUA in English 0822 GMT 6 Jul 87

[Text] Nanjing, 6 July (XINHUA)--China has for the first time succeeded in turning coal into gas, according to coal industry experts who approved an experiment in Xuzhou City, Jiansu Province, recently.

Gasification of coal that is still underground is set on fire which turns it into gas.

The experiment was carried out by the Chinese Institute of Mining Industry and the Xuzhou Coal Industrial Company in a deserted coal stratum on the outskirts of Xuzhou City.

According to a report, the experiment generated 160,000 cubic meters of coal gas between March and May this year.

An expert said the success of the experiment will be of great importance to China's coal industrial development. It will help change the traditional way of mining and fully open up coal resources.

With conventional mining only 40 percent of coal resources are used but 95 percent of the coal resources can be tapped with the new gasification technique, the expert added.

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CSO: 4010/59

BRIEFS

COAL EXPORTS INCREASE--Beijing (CEI)--China exported 5.996 millions tons of coal in the first half of 1987, 24 percent more than the corresponding period of last year, according to China National Coal Import and Export Corporation. The corporation dispatched 10 sales groups abroad and invited foreign customers to visit Chinese mines and harbors. China is now exporting coal to more than 20 countries and regions, including Japan, the Philippines, Indonesia, France, Belgium, Denmark, Argentina, Iran, and Hongkong. [Text] [Beijing XINHUA in English 0451 GMT 8 Jul 87 OW] /12232
CSO: 4010/60

INDUSTRY FAILS TO MEET MID-YEAR PRODUCTION TARGET

OW101433 Beijing XINHUA in English 0534 GMT 10 Jul 87

[Text] Beijing, 10 Jul (XINHUA)--China's oil industry did not grow as much as expected in the first 6 months of this year and will have to increase its daily output in the second half in a bid to meet the year's target of 134 million tons of crude oil, according to CHINA DAILY today.

By the end of June, China produced 65.34 million tons of crude oil. Although this was a 4.09 percent increase over the same period last year, it is only 49 percent of the year's total target. It produced 6.95 billion cubic meters of natural gas, a 2.5 percent rise over the same period last year, said an official from the Ministry of Petroleum Industry.

China has put 2,191 new oil wells into operation, 716 more than the same period last year. They will add 4.48 million tons to the country's oil production capacity.

The official said the ministry is expected to put 960 new oil wells into operation, and increase its daily output by 5,000 tons in the second half of the year.

The official said the ministry is optimistic about future production. It is possible for the industry to fulfill this year's target by the end of October. The target is set at 134 million tons of crude oil and 13.5 billion cubic meters of natural gas.

Officials from the ministry said oil fields which went into production before 1985 have pumped out almost 90 percent of the country's total production.

In addition to old oil fields, the new fields added an additional production capacity of 10.42 million tons last year.

Meanwhile, in northwest China, the Changqing oil field has oil reserves totalling 300 million tons. It produces 1.4 million tons a year.

Six natural gas wells were drilled after obtaining 300,000 cubic meters of gas from a test well sunk last year in the oil field which borders Shaanxi and Gansu provinces and the Ningxia Hui Autonomous Region.

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CSO: 4010/61

JANUARY-JUNE '87 PETROCHEMICAL OUTPUT, SALES NOTED

OW0606l2 Beijing XINHUA in English 0540 GMT 6 Jul 87

[Text] Beijing (CEI)--The output value of China's oil industry in the first 6 months of this year reached 17.8 billion yuan, with a sales volume totalling 22.37 billion yuan, according to the China Petrochemical Corporation. They are increased respectively 12 and 17 percent over the same period of last year.

A break-down shows:

Item	output
Petroleum	56.77 million bbl
Kerosene	14.7 million bbl
Diesel oil	78.54 million bbl
Lubricating oil	5.74 million bbl

(Note: The above figures represent an increase of 5 percent compared with the first half of last year)

Urea	2.3 million tons
Chemical fibre	173,000 tons
Plastics	367,000 tons
Synthetic rubber	74,000 tons

(All Overfulfilling the state plan 1 month ahead of schedule)

Daqing oil field, one of China's major oil producers, turned out 192.5 million bbl of crude oil in the first 6 months.

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CSO: 4010/59

INDUSTRY DEVELOPMENT FOCUSES ON EAST, BOHAI BAY

OW200204 Beijing XINHUA in English 0147 GMT 20 Jun 87

[Text] Beijing, 20 Jun (XINHUA)--China's oil industry will focus current development projects on the Shangli oil field in east China's Shandong Province, senior official Kang Shien announced today.

Kang Shien, State Councillor and former minister of the petroleum industry, said, in today's overseas edition of "PEOPLE'S DAILY, "the Shengli oil field is expected to pump 350 million barrels in 1990, based on 1986's 210-billion barrel figure."

Kang also said, efforts of Chinese scientists over the past three decades have helped locate more large deposits, and new technological discoveries have helped in extracting oil from inaccessible geological structures since the 1960's.

"We once thought Eastern China had oil reserves of about 70 billion barrels, and total annual output would be about 70 million barrels," Kang said, "but now it's been determined the Shengli oil field alone has reserves of 35 billion barrels, and can pump 3.5 million barrels a year, much more than expected."

"Oil development will focus on the Bohai Bay area at the end of this century," Kang said, adding prospecting in western China looks promising, and large oil fields will soon be started up there.

China's total oil production is expected to hit 1.05 billion barrels by 1990, and to climb to 1.75 billion barrels by the year 2,000, to meet the needs of the domestic market, Kang concluded.

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CSO: 4010/56

OIL PRODUCTION CAPACITY REINFORCED IN PAST YEAR

OW071020 Beijing XINHUA in English 1002 GMT 7 Jul 87

[Text] Beijing, 7 July (XINHUA)--Efforts of more than a year in regulating old oil fields and opening new ones have reinforced China's oil production capacity.

Statistics released by the Ministry of Petroleum Industry here today show that the annual growth rate of moisture content of the country's old oil fields decreased to 1.6 percent from 2.9 percent, and natural diminution rate went down to 15.2 percent from 16.3 percent in 1985. All the major oil fields such as Daqing and Shengli are "enjoying steady production."

Officials of the ministry speak highly of this progress. They say that old oil fields put into operation before 1985 have pumped out almost 90 percent of the country's total crude oil.

In addition, the development of new oil fields has been sped up. According to the ministry, China has added new production capacity of 15.96 million tons last year, of which 10.42 million tons came from new oil wells.

And the trend remains this year. By 20 June, China has put 2,191 new oil wells into operation, 716 more than the same period last year. They produced 2.35 million tons of crude oil between January to June, 416,000 tons more than the same period last year.

For the second half this year, the ministry plans to erect another 960 new il wells and to rise the daily output by 5,000 tons.

Officials of the ministry are optimistic about future production. They say it is possible for the industry to fulfill by the end of October the yearly plan that requires 134 million tons of crude oil and 13.5 billion cubic meters of natural gas.

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CSO: 4010/60

NEW WELLS OPERATIONAL, PRODUCTION RISES

OW080552 Beijing XINHUA in English 0543 GMT 8 Jul 87

[Text] Beijing (CEI)--China put 2,191 new oil wells into operation between January and 20 June this year--some 716 wells more than in the same period last year. They produced 16.48 million bbl of crude oil in the first half of this year, 2.9 million bbl more than in the same period last year.

In the second half of this year, the Ministry of Petroleum Industry plans to sink another 960 oil wells and to raise the daily output by 35,000 bbl.

China added new production capacity of 111.7 million bbl last year, of which 73 million bbl came from new oil wells.

Officials of the ministry are optimistic about future production. They say it is possible for the industry to fulfill by the end of October the yearly plan that requires 938 million bbl of crude oil and 13.5 billion cubic meters of natural gas.

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CSO: 4010/60

INCREASED DAQING OUTPUT LAID TO RECENT REFORMS

OW141224 Beijing XINHUA in English 1212 GMT 14 Jun 87

[Text] Beijing, 14 June (XINHUA)--Daqing, the country's largest oil producer in the northeast province of Heilongjiang, pumped out 260,610 barrels of more crude oil in January-April, this year, than in the same 1986 period, China's leading newspaper reported today.

Natural gas output in this period was 61 million cubic meters more than in the same 1986 period, the PEOPLE'S DAILY said, adding that the oil field produced 405.51 million barrels of oil last year.

The paper attributed the success the 27-year-old oil field has made to the introduction of the factory director (manager) responsibility system to the leadership of the oil field at all levels.

Linking the economic performance with the interests of the oil workers, the paper noted, the responsibility system has helped encourage the workers to pump out more oil for the country.

The oil field put most of their retained profits into the expansion of production with the average annual sum being 320 million yuan (some 86.5 million U.S. dollars) over the past 6 years, the paper said, and this has helped add some 3.65 billion barrels of oil reserve in the periphery of the oil field, it added.

Oil wells in the periphery going into production every year have a combined production capacity of 2.92 million to 3.65 million barrels and they have so far produced a total of 13.87 million barrels, it added.

To promote the multi-purpose use of its crude oil, Daqing has added an oil refinery, a chemical fertilizer plant and an ethylene works in addition to 101 small industrial enterprises.

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CSO: 4010/59

BOHAI FIELD BEGINS 'OFFICIAL' PRODUCTION

OW102008 Beijing XINHUA in English 1506 GMT 10 Jun 87

[Text] Tianjin, 10 Jun (XINHUA)--The Chengbei oil field in north China's Bohai Sea, jointly developed by Chinese and Japanese companies, is now in official commercial production, after the 24th well at an offshore platform gushed oil this afternoon.

The Chengbei oil field covers about 10 square km in the southwest of the Bohai Sea, 74 km from Tianjin's Xingang harbor. The oil field was discovered by Chinese geologists in the 1970s and co-prospected by China and Japan, an official from the Bohai Petroleum Corporation of China (BPCC) told XINHUA.

Of the two platforms in the Bohai Sea, platform A consists of production and living areas, and is connected with platform B by a 1.6-km oil pipeline. Platform B, which was put into operation in September 1986, has oil storage facilities and a jetty capable of accommodating 10,000 dwt oil tankers.

The Chengbei oil field has an annual capacity of 2.8 million bbl for at least ten years. More than 840,000 bbl of oil have been shipped out from the oil field so far, according to the official.

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CSO: 4010/54

NEW DEVELOPMENTS IN NATURAL GAS EXPLORATION REVIEWED

Chengdu TIANRANQI GONGYE [NATURAL GAS INDUSTRY] in Chinese No 1, 28 Mar 87 pp 1-4

[Article by Zhang Wenzhao [1728 2429 2507], Ministry of Petroleum Industry Exploration Office: "New Development in Recent Natural Gas Exploration in China"]

[Text] Abstract: This article summarizes the main achievements in recent natural gas exploration in China and proposes some ways for natural gas exploration in the future. From recent oil and gas exploration practice and analysis with geological theory, it is shown that the natural gas exploration in China has a vast world where much can be accomplished. The existing problems and measures to be improved in current exploration are also indicated in the paper.

China is a country in which continental basins predominate, the geological conditions for natural gas formation are superior and oil and gas resources are abundant. In the large basins natural gas is widely distributed in a multiplicity of types and gas fields have been discovered in nine systems from Quarternary to Sinian. In terms of causative factors, there are oil field gas, over-mature gas, deep strata fracture gas, shallow strata biogas, coal-formed gas, carbon dioxide gas, and dissolved gas. China's natural gas exploration has not yet been developed comprehensively. In oil-gas coexploration, great advances have been made recently in natural gas exploration, there have been new breakthroughs especially in coal-formed gas exploration. During the Sixth Five-Year Plan, China discovered and verified such important gas fields as Yinggehai ya 13-1, Kekeya, Suqiao, Wenliu, Baimiao, and Shaguanping, with the newly increased reserves making up 33.4 percent of the total reserves and is the 5 years with the largest increase in reserves since the founding of the People's Republic of China.

1. The Ya 13-1 Major Gas Field Discovered in Yinggehai

This gas field, situated more than 100 km south of Hainan Island, is a simple anticline gas deposit with very large proven reserves and currently has four wells obtaining industrial gas flow. The gas producing stratum is lower Tertiary Lingshui group, gas stratum thickness is >100 m, single well output is 500,000 to 1 million m^3/d, and is one of the large-scale gas fields which have currently been discovered in China.

The natural gas composition of the natural gas from this field is: methane, 84.1-89 percent, heavy hydrocarbons, 1-4.6 percent, CO_2 as high as 8-11.5 percent, $\delta_{13}C_1$ = -34.7 to -36.8 per thousand. The storage layer is a coal system, thus it may be coal-formed gas.

South of Ya 13-1 a series of anticline entrapments were discovered including two high pressure gas indications strata sections from 3228-3921 m at the No 1 exploration well in Donglo 30-1 structure. Integrating with regional geological analysis, the Yinggehai western basin is an elongated belt of the Honghe rift valley, the northeast wing of the basin descends toward the sea and is buried to a depth of over 10,000 m and is favorable for production of deep strata fracture gas. From analysis of storage, gap, and entrapment conditions, the coastal high energy sandstone, phosphate rock and turbid sands in the Miocene series Meishan group and the Oligocene series Lingshui group are the primary reservoirs. The Pliocene and Miocene Huangliu group and Yinggehai group mudstone development, with large single stratum thickness and wide area of distribution are ideal regional cap strata. The entrapment developments within the area are of many types including bed rock pifu [2126 1788] anticline, reverse drawn anticlines, ancient submerged mountains, fault noses, bioherms, mud hills, etc. Thus Yinggehai is a very promising gas-bearing rift valley basin and further explorations might find a gas-bearing area.

2. High Producing Gas Flow Obtained in the Paleozoic Group in the Tianchi Structure in the Ordos Basin

The Tianchi structure is situated in the Tianhuan syncline in the Ordos Basin, a "bulge in a concavity," in the fifties it was discovered that the gravitational force is high, and after many seismic overlay surveys it was proven to be a dome anticline with an area of 53 km^2 with a range of 200 m. In September 1986 exploratory drilling was carried out and mud loss was discovered in Ordovician limestone. In midway tests 328,000 m^3/d gas was obtained, and reserves are still being verified. Natural gas indications in the Paleozoic group in the Ordos Basin are very extensive and over 10 wells have been drilled in the Carboniferous and Permian series in the middle section of the fault fold on the western edge of the Ordos Basin and industrial gas flow has been obtained and some of the reserves verified; in the Yimeng bulge region in the north of the basin there are also several wells which have obtained gas flow from the Permian system; and gas and gas indications have also been seen in the bend zone in the east of the basin. In recent years, after acidizing the weathering crust of the top of the Ordovician system, 17,300 m^3 of gas was obtained from the Qican 1 well drilled in Qilingou, Zizhou in the belly of the basin. The above facts prove that there are regional gas-bearing possibilities in the Paleozoic group of the Ordos Basin and as long as entrapments exist industrial gas deposits may have been formed.

The Ordos Basin is a deeply buried, well-preserved jumei [5112 3561] basin, Carboniferous and Permian coal strata and scattered organic deposits are very abundant, indicating that the coal-formed gas reserves are very large. The Mesozoic group in this basin is primarily oil bearing, the Paleozoic group is primarily gas bearing, and the oil and the gas are controlled by

two large planes of unconformity: the eroded surface of the top of the Triassic elongation system controls the petroleum reservoir; the eroded surface of the top of the Ordovician controls the natural gas reservoir. If these two planes of unconformity and the covering structures are conscientiously surveyed a precise structural map can be drawn and the favorable distribution area for oil and gas deposits can be predicted and this is the key to finding oil and gas in this basin.

3. Industrial Gas Has Been Found in Many Places in the Lishu-Dehui Depression in the Southeast Part of the Songliao Basin

The Lishu-Dehui depression is a Jurassic fault depression concealed in the southeast part of the Songliao Basin, the Maoshan, Nongan, and Sijiazi structures in the fault depression have already struck industrial gas from many exploratory wells in Jurassic and Cretaceous systems and CO_2 gas has been obtained from Wanjinta structures.

There is a 5 meter thick gas stratum in Cretaceous, Quantou group Quan 1 section at a well depth of 1,468-1,473 m in the Lican 1 well in a Maoshan structure, with a daily gas production of 60,000 m^3. Recently, 20,000 m^3/d of gas was obtained in a Jurassic-Cretaceous system at Si 2 well, in a Sijiazi structure at a well depth of over 1,000 m. There are seven wells in the Nongan structure which have hit industrial gas. Two wells in the Wanjinta structure have obtained CO_2 gas with a daily production of as much as 100,000 m^3. From the composition of the natural gas from Lican 1 well we can see that methane is 91.9 percent, $\delta_{13}C_1$ = -40 to -30 per thousand, mercury content is 18.75 ng/m^3, equivalent to that of the large Groningen gas field in Holland ($\delta_{13}C_1$ is -36.6) and should be coal-formed gas type.

The Lishu-Dehui depression is currently the largest Jurassic fault depression in the Songliao Basin with an area of 6,000 km^2, with bed rock buried at 10,000 meters at most. The Jurassic system is a coal-bearing stratum, 8,600 m thick, and in it the trap mud stone is 300 m thick, the cumulative thickness of the coal strata is 15 m and it is predicted that the natural gas resources are very large. This depression produces both oil and gas and the area of exploration is very wide: the first is authogenic and self-storing oil and gas deposits found in Jurassic; the second is an ancient submerged mountain oil and gas deposit found along the bottom of the Jurassic; the third is a large anticline oil and gas deposit "producing below and storing above" explored in Lower Cretaceous Quantou group. There are many structures in this area, oil and gas deposits are buried shallowly, it is close to large industrial cities, communication is convenient and it is the most practical area for exploration in the Seventh Five-Year Plan.

4. Gas Deposits Discovered in Lower Cretaceous Quantou Group in the Northeast Part of the Songliao Basin

Industrial type gas flow has been discovered generally in the vast area between Songzhan and north of Shengping in the northeast part of the Songliao Basin. Industrial gas flow has been obtained from Fuyuyang and Dachengzi oil strata buried at depths of 1,000-1,800 m at Song 2 and at Shen 61 and 81 wells.

In the natural gas composition, methane is 92-95 percent, heavy hydrocarbons are 1.5-3.5 percent, nitrogen is 3-5 percent, and in particular, $\delta_{13}C_1$ is -39 to -29 per thousand, which is different from the oil-type gas of the Daqing Oil Field.

In terms of regional structures, this region is situated on the ridge at the intersection of the Anda and Shengping synclines along the eastern face of the Daqing wall. According to analysis of seismic materials, many of the faults in the Quantou fault block structures extend downward from the Fuyu group and enter the Jurassic and this provided a channel for the upward migration of oil and gas produced in Jurassic and Denglouku groups. Oil and gas indications were recently discovered extensively in Quantou group of the eastern part of the basin. The high stratum position is over 300 m from the bottom of the overlying Qingshankou group (oil-producing rock), thus it cannot be the result of downward migration of oil and gas produced by Qingshankou group. From the carbon isotope characteristics of the natural gas methane it can be seen that the natural gas in this area is different from the oil type gas composed from the central portion of the Daqing Oil Field ($\delta_{13}C_1$ is -45 to -50 per thousand), but is basically the same as the coal-formed gas here and abroad. Summarizing the above, we feel that the source of the natural gas in the northeastern part of the basin may come from deep Jurassic coal series, and the contributing factors are similar to the Lishu-Dehui depression. Thus, intensifying exploration of deep Jurassic fault depression basins is necessary for opening up new territory for finding gas in the Songliao Basin.

5. Permian Bioherm Gas Deposits Discovered Widely in the Chuandong Area

Carboniferous gas deposits were discovered in the seventies in the Chuandong region of the Sichuan Basin and recently bioherm gas deposits were widely discovered in Upper Jurassic Changxing group. Industrial gas flow of 370,000 m^3/d was first obtained from Shibao 1 well bioherm in 1984. In the past 2 years bioherm exploration and research has also made great advances and a total of 8 bioherm points have been discovered up to now and four bioherm gas deposits have been obtained. The Sichuan Petroleum Management Bureau's use of seismic information to study the characteristics has been fruitful and has summarized in a preliminary way three types of reflection characteristics of bioherms in seismic cross-sections, the Wolonghe oil field's Wo 117 well is a test well planned on the basis of seismic abnormalities, and after test drilling not only established that a bioherm existed but also obtained industrial gas flow. Seismic materials have been used to find 67 herm points.

The distribution range of Chuandong-Exi Changxing group bioherm is broad, within 53,000 km^2, and in addition to outcrops, there is 30,000 km^2 of Changxing group buried in Chuandong and 10,000 km^2 in Exi, and is a large area for exploring herm-type gas deposits. In addition, the Changxing group bioherm has a thick reservoir stratum and high porosity (5-8 percent) which are conditions for high output. For example, the Shuanglong structure's Shuang 15 well herm is 50 m thick, 44 meters of which has a porosity of >3 percent, with an average porosity of 7 percent, and test daily output of 1.02 m^3 of gas.

6. The Suqiao Gas Field Discovered in North China Jizhong Depression Paleozoic Group

The Suqiao gas field situated on the Wen'an slope belt in the northeastern part of the Jizhong Depression, is an ancient submerged mountain gas deposit with oil at the bottom, currently four fault blocks have been explored, over 20 km long from north to south, 2-3 km wide, the natural gas deposits verified are considerable, and industrial gas flow has been obtained from Carboniferous and Permian to Ordovician. The Carboniferous and Permian sandstone is coarse and thick, and according to the analysis of cores taken from Su 20 well, average porosity is 16.3 percent, permeability rate is $2,260.49 \times 10^{-4}$ μm^2, which are high output conditions. For example, the 3,342-3,392 m sections of the Su 20 well had three 38 m thick strata of sandstone, and using a 12 mm oil mouth produced daily 210,000 m^3 of gas and 134 m^3 of ningxi [0413 2649] oil.

The $\delta_{13}C_1$ of Suqiao gas field natural gas is -39 to -35 per thousand, different from the oil-type gas from the Jizhong oil field ($\delta_{13}C_1$ of -48 to -41 per thousand) and the biogas ($\delta_{13}C_1$ of -56 to -55 per thousand), mercury content is as high as 354,000 ng/m^3 and thus is determined to be coal-formed gas. This oil and gas field is situated in a Carboniferous and Permian coal series distribution area, the Carboniferous and Permian series are widely distributed in the Wen'an-Yangcun slope, east to the Canxian bulge, and is also distributed south to the Shenxian region, the exploration territory is rather wide.

7. Natural Gas Indications Discovered in Lower Triassic Strata in Wenliu and Baimiao Gas Fields in the Central Plain Puyang Depression Are Very Widespread

The Baimiao and Wen 23 block gas fields discovered and verified in Puyang Depression Lower Triassic are very large reserves. In recent years test wells drilled into deep strata at 3,500-5,000 m in the Dusai, Qiaokou and Baimiao area widely discovered high pressure gas indications and obtained industrial gas flow from deep strata in Baimiao structures. Using a 4 mm oil mouth at a well depth of 3,759-3,769 m in Qiao 14 well daily gas output was 46,000 m^3, and high pressure gas flow appeared at >4,000 m deep strata in Qiao 20, 24, and 25 wells.

The Puyang Depression is one of the deepest fault depressions in China and organic rocks are buried to a depth of more than 10,000 m. From the perspective of regional geological conditions, in the deep Lower Triassic strata of this depression there are enormous regional gaoyan [5221 7770] strata, 500-600 m thick, below which there are well-preserved Carboniferous and Permian series, which are both favorable for formation of coal-formed gas and deep strata fracture gas as well as excellent preservation conditions and it is a very likely deep strata gas-bearing region. It should be pointed out that entrapments below Lower Triassic Sha 4 yan are hard to clean out, the reservoir strata are rather dense, in the future it will be necessary to intensify research on strata structures, give serious consideration to protecting gas strata and improving gas strata, and developing well-drilling

technology campaigns to be able to open up the situation in finding gas in deep strata.

8. High-Pressure Gas Deposits Discovered in Liaodongwan

At the end of the seventies, the Liao 1 test well was drilled in Liaodongwan, and the Jin 20-2-1 well was drilled in the Jin 20-2 structure in 1984, obtaining high output gas flow in the Lower Triassic Sha 1 section, this well shot open Sha 1 section baiyun rock, and two high-pressure oil and gas strata 35 m thick at a well depth of 2,158-2,203 m which using a 9.5 mm oil mouth daily produce 227,000 m^3 of gas, 85.4 m^3 of ningxi [0413 2649] oil, net pressure of 33.5 MPa and flow pressure of 30.8 MPa.

The Liaohe Depression of Liaodongwan and the continent is one entity and is one region of the subsidence in depressions is the deepest; there are organic rocks buried in the depression to a depth of 8,000 m, which is very favorable for formation of deep strata fracture gas. This area has many fault anticlines, many kinds of entrapment, preservation conditions are good, reservoir strata matter is good, there are a variety of favorable conditions for both oil and gas and it may form a double-duty oil and gas reservoir area. From the perspective of recent exploration results, the gas deposits in the depression in the western part of Liaohe gradually increase from north to south, and in the Shuangtaizi, Shuangnan, Rongxingtun district of neighboring Liaodongwan, gas stratum gas and gas top gas deposits are very well developed, thus we may hope to find even more gas fields in the Liaohe Depression south section-Liaodongwan north section.

9. Oil and Gas Field Discovered in the Hekeya and Northern Tarim Bulge in the Tarim Basin

The Hekeya oil and gas field situated in the southwest depression of the Tarim Basin is an Upper Triassic secondary oil and gas deposit and during the Sixth Five-Year Plan the oil and gas geological reservoirs (mainly gas) were verified. The primary oil producing strata of the southwest depression are Lower Triassic, Jurassic-Cretaceous, and Carboniferous, the Upper Triassic gas supply follows a fault from deep strata, violent natural gas indications were discovered in drilling to Triassic at 5,600 m in He 50 well, which is immediate proof. The extent of current exploration of the southwest depression is very low, finding gas in Hekeya deep strata and finding further Upper Triassic secondary oil and gas deposits in the vicinity are very promising but require further exploration.

Since a violent blowout occurred at a well depth of 5,193 m at the Shacan 2 well on the Yakela structure in the Tabei [northern Tarim?] bulge in 1984, after 2 years of test extraction it is continuing to produce oil and gas. In the five exploratory wells drilled in the surrounding area there are also two exploratory wells which have obtained industrial oil and gas flow (Sha 4 and 7 wells). The plane of unconformity between the Mesozoic group and Paleozoic group in this area controls oil and gas reservoirs and thus further clarification of the planes of unconformity and the structure of the overlying strata is a key to finding oil and gas deposits.

10. Industrial Gas Flow Obtained at the Pinghu 1 Well in the East China Sea

The East China Sea's Pinghu 1 well is the first well in which oil and gas were discovered: two groups of gas strata were discovered in the Triassic series in this well at a depth of 2,972-3,618 m, with daily gas production of 130,000-250,000 m^3.

The area of the East China Sea Basin which is 250,000 km^2, is a depositional area of mostly Triassic continental facies, the deepest part of the basin's subsidence is over 10,000 m, the organic types are continental muck and humus types, tending toward the humus type. From analysis of the geological conditions, the Xihu and Wendong depressions of the East China Sea Basin are promising areas. There are many anticlines here, the entrapment area is large, sometimes more than 800 km^2, and combined with the Pinghu, Yuquan, and Chunshao structure area, the area of favorable conditions is 100,000 km^2, the geological conditions are excellent and it is worth further exploration.

Summarizing the above, from the perspective of China's near-term practice in oil and gas exploration, we have eloquently proved that China has a vast area for natural gas exploration where much can be accomplished. From analysis in terms of geological theory, China has many large continental basins, many coal-bearing strata, large coal reserves, large and deep depressions, which are very favorable for formation of natural gas and the conditions for forming reservoir strata, entrapments, covering strata, and preservation of large gas fields are favorable and the excellent geological conditions must have formed many large gas fields. However, there are still some weak links in China's natural gas exploration, such as long-term oil and gas co-exploration for specialized exploration ranks have not yet been formed, the scientific research ranks are weak, exploration technology and methodology are basically those used for petroleum and are not suited to the characteristics of natural gas, such policies as natural gas pricing are not workable, etc. These all have an impact on the initiative of exploration and development departments. In the future in the spirit of transformation we should promote the development of China's natural gas exploration and development and believe that in the not too distant future we will certainly create a new situation in the natural gas industry.

(Date this article was received: 1 December 1986)

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CSO: 4013/63

BRIEFS

OIL EXPORTS UNCHANGED--Beijing, 11 Jul (XINHUA)--China will keep its crude oil exports at the 1986 level in support of OPEC measures for a stable oil market, the INTERNATIONAL BUSINESS journal reported today. Zheng Dunxun, general manager of the China National Chemicals Import and Export Corporation, was quoted as saying "We appreciate the agreements reached at the OPEC's 81st meeting of ministers on oil output limitation." "We hold that keeping oil prices at a reasonable level benefits both oil producers and consumers," he said. [Text] [Beijing XINHUA in English 1127 GMT 11 Jul 87] /8309

EAST CHINA SEA STRIKES--Shanghai, 2 May (XINHUA)--Another exploratory well hit oil and gas flow of industrial value in the East China Sea during a recent survey exploration, according to oil officials here today. The Pinghu No. 3 well on the Pinghu structure is about 400 kilometers away from Shanghai. This is "another breakthrough" in oil exploration in the East China Sea, the officials said. In recent years, eight out of ten exploratory wells sunk around the area have reported oil and gas showings and Pinghu No. 1 and Pinghu No. 2 reported oil-gas flows of industrial value in 1983 and 1986 respectively. Chinese geologists say that the latest discovery provided an important basis for China to select major exploration areas in the East China Sea. [Text] [Beijing XINHUA in English 1540 GMT 2 May 87 OW] /12624

EASTERN JUNGGAR BASIN FIELD PRODUCING OIL--Urumqi, 26 Jun--(XINHUA)--The oil field in the eastern part of the Junggar Basin in the Xinjiang Uygur Autonomous Region began pumping oil early this month. The oil is transported to the Urumqi Petrochemical Works to be refined. Over the past few years, the Xinjiang Petroleum Bureau has sunk dozens of wells in this region, which covers about 20,000 sq km of grassland and desert in Fukang, Jimsar, and Qitai countries, north of the Tianshan Mountains. Now, 17 of these wells have produced oil. "The prospecting shows that this region has extensive oil-bearing seams and bright prospects for further exploration, said an official from the bureau. Commodity oil has also been produced by nine wells in the Huoshao mountains area. Some 5,000 workers are busy laying oil and water pipelines and building oil tanks. [Text] [Beijing XINHUA in English 1350 GMT 26 Jun 87 OW] /6662

CSO: 4010/57

BRIEFS

DAYA BAY PROJECT--Shenzhen (CEI)--A credit agreement involving French loans for the civil engineering work on the Daya Bay nuclear power plant was signed on 13 June in the Shenzhen Special Economic Zone. According to the agreement, the Bank of China will get 700 million French frances from the Banque Nationale de Paris and Banque Francaise du Commerce Exterieur and transfer the funds to the Guangdong Nuclear Power Joint Venture Company. Xu Shenguan, chief accountant and financial manager of the Guangdong Nuclear Power Joint Venture Company said his company signed a trade agreement with the Maeda Co., Ltd. of Japan on 11 June for loans of 3.6 billion Japanese yen in funds for the project. To date, 60 percent of capital needed for the project has been raised, and the remainder will be arranged by commercial credit or from shareholders' funds. [Text] [Beijing XINHUA in English 0552 GMT 29 Jun 87 OW] /12624

CSO: 4010/56

GEOTHERMAL RESOURCES EXPLORATION STEPPED UP

OW181303 Beijing XINHUA in English 1043 GMT 18 May 87

[Text] Beijing, 18 May (XINHUA)--China has [stepped up] exploration and utilization of the country's geothermal resources in recent years, CHINA ADVERTIZING DAILY reported today.

"To date, 2,500 thermal springs have been located nationwide, and the energy given off by these springs is the equivalent of 3.7 million tons of coal," the paper said.

"Geologists estimate central and east China's available geothermal resources, within 3,000 meters of the earth's surface, could produce energy equivalent to 300 billion tons of coal," the paper said, "and the potential for developing geothermal energy reserves in the west is even greater."

According to the report, "geothermal energy is now being widely used in industry and for daily energy consumption needs, and geothermal energy is much cheaper to use to generate electricity than coal."

The paper cited Beijing, Tianjin, Fuzhou, Kunming, Xi'an, Zhengzhou, and Jinan as cities with plentiful geothermal resources. Beijing's Xinqiao Hotel now uses a newly tapped geothermal energy source to supply hotel guests hot water and central heating.

The paper warned cities against the overuse of geothermal resources, which in some areas has caused the sinking of urban areas because of excessive pumping.

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CSO: 4010/50

BRIEFS

HUNAN RURAL ENERGY DEVELOPMENT--Changsha, May 9 (XINHUA)--Hunan Province in Central China has set the pace in developing rural energy and easing firewood shortage. According to the province's rural energy office, the province as a whole built about 130,000 methane-generating pits and 4.6 million efficient coal stoves, an increase of four times and 20 times respectively over the 1982 figure. According to statistics of the rural energy office of Hunan Province, 6,600 peasant households in 120 villages in the suburbs of Changsha City and 12 percent of the total peasant households have methane gas supplies. The gas is used for heating and cooking and has replaced 6,600 tons of coal annually, worth 400,000 yuan. To date about 50 percent of the peasant households in the province use efficient wood or coal stoves. They save about four million tons of firewood worth about 100 million yuan. The province's rural energy office has trained thousands of peasant technicians and set up service companies to serve the methane generating pits. [Text] [Beijing XINHUA in English 0700 GMT 8 May 87 OW] /8309

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